

# Chapter 2: Foundations of Future Defense

## Blueprint for Action

The Department of Defense (DoD) lags far behind the commercial sector in integrating new and disruptive technologies such as Artificial Intelligence (AI) into its operations. Technical, bureaucratic, and cultural challenges must be overcome to adopt AI to maintain the U.S. military advantage. By 2025, the DoD must put in place the foundations for widespread AI adoption, by: 1) Building the technical backbone; 2) Training and educating warfighters; 3) Accelerating adoption of existing digital technologies; 4) Democratizing development of AI; and 4) Investing in next-generation capabilities. To the maximum extent possible, these efforts should be coordinated with the Intelligence Community (IC) and other partners across the national security community.<sup>1</sup>

### Recommendation

*Recommendation: Drive Change through Top-Down Leadership.*

Maintaining the defense advantage in an AI-enabled future will require top-down leadership to overcome organizational barriers and create strategic change. Critically, civilian and military leaders across the DoD and the IC must coordinate more closely, aligning priorities, resources, and policies to speed technology adoption and research breakthroughs.

Actions for the Department of Defense and the Office of the Director of National Intelligence:

- **Establish a Steering Committee on Emerging Technology, tri-chaired by the Deputy Secretary of Defense, the Vice Chairman of the Joint Chiefs of Staff, and the Principal Deputy Director of National Intelligence.**<sup>2</sup>
  - o The Secretary of Defense and Director of National Intelligence should issue a directive immediately establishing the senior oversight committee listed above.
  - o The Steering Committee on Emerging Technology provides a forum to drive change, focus, and action on emerging technology that otherwise would not be prioritized. It will enhance intelligence analysis related to emerging technology; connect strategic vision to organizational change; focus concept and capability development on emerging threats; guide defense investments that ensure America's strategic advantage against near-peer competitors; and provide the authority to drive technology adoption and application by the Department.
- **Assign the tri-chaired Steering Committee on Emerging Technology responsibility for overseeing the development of a Technology Annex to the next National Defense Strategy.**<sup>3</sup>

Action for Congress:

- **In the National Defense Authorization Act (NDAA) for FY2022, establish a Steering Committee on Emerging Technology and National Security Threats and designate that it be tri-chaired by the Deputy Secretary of Defense, the Vice Chairman of the Joint Chiefs of Staff, and the Principal Deputy Director of National Intelligence.**

*Recommendation: Build the Technical Backbone*

Recommendation

Integration of AI into DoD operations requires urgent investment in a modern digital ecosystem that will enable ubiquitous development and fielding at all levels—from the headquarters to the tactical edge. It is essential to establish a technical foundation that:

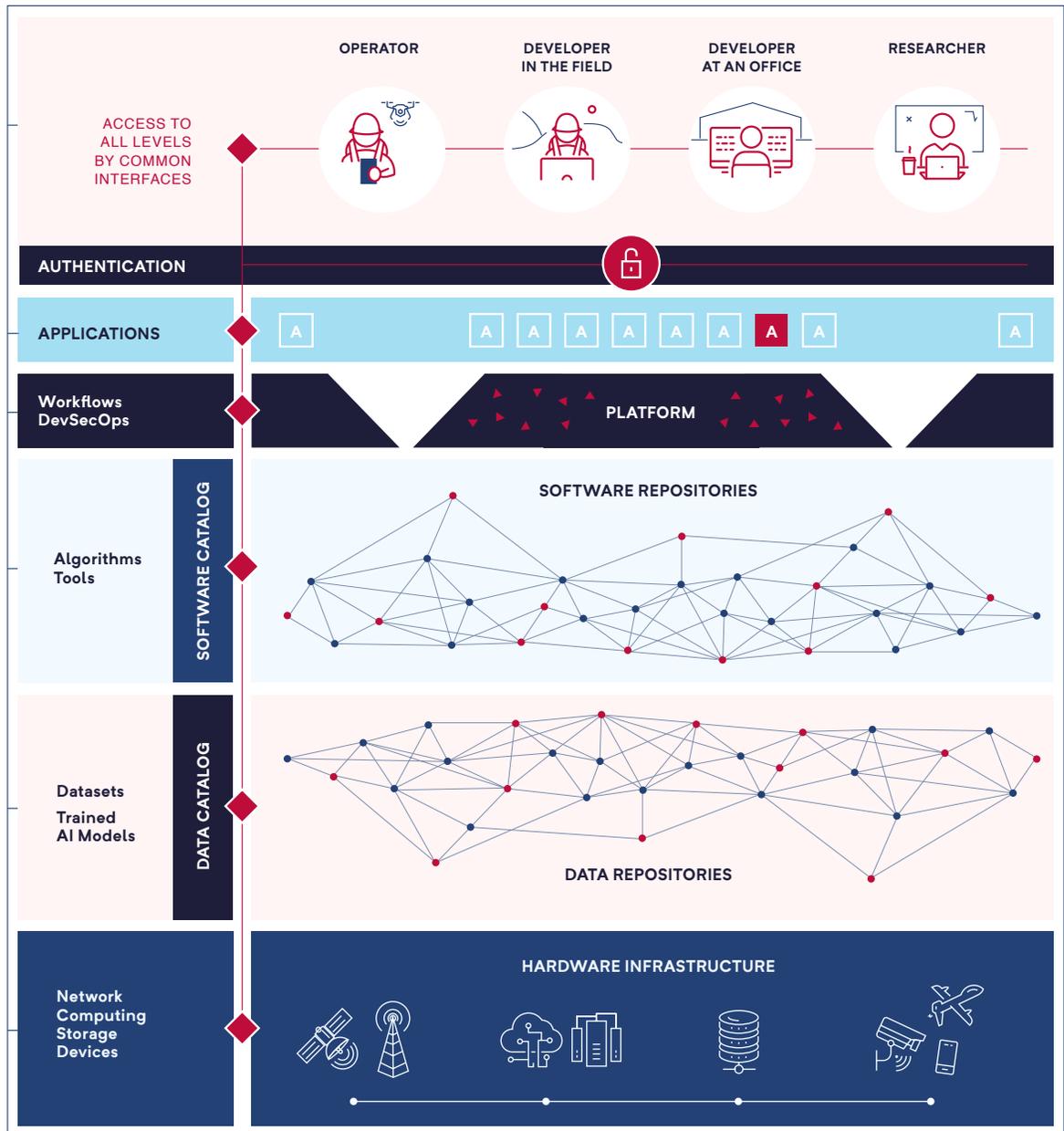
- 1) Provides access to leading cloud technologies and services for scalable computing;
- 2) Enables the sharing of data, software, and capabilities through well-documented and hardened application programming interfaces (API) with proper access controls; and
- 3) Gives all DoD developers and scientists access to the tools and resources they need to drive new AI capabilities. To this end, the figure below depicts the ecosystem managed as a multilayer stack of services, accessed through common interfaces and providing shared access to essential AI building blocks of data, algorithms, tools, trained AI models, and compute. This should be realized through a federated approach, building on existing resources and pathfinder efforts.<sup>4</sup>

The key elements that comprise the envisioned AI digital ecosystem are:

- *Contributors and Users.* A diverse, distributed network that includes development teams working at the tactical edge and at headquarters levels; private sector partners contributing trained models and applications; academic researchers working on open challenge problems; researchers working within a DoD lab; or international allies or partners co-developing interoperable AI capabilities.
- *Common Interfaces.* A service-oriented architecture where resources at each level of the stack are accessed and maintained through common APIs based on industry-standard protocols.
- *Authentication.* Enhancing both the sharing and the safeguarding of resources through a uniform policy and practice for managing authoritative, shared user attributes across classification levels to control who will build, use, or share AI building blocks.<sup>5</sup>
- *Applications.* Discoverable and accessible AI solutions ready for fielding through provisioned platform environments.<sup>6</sup>
- *Platforms.* Environments that support development, testing, fielding, and continuous updating of applications to diverse sets of contributors and users.<sup>7</sup> These platforms include workflows and processes supporting the DevSecOps<sup>8</sup> life cycle, MLOps<sup>9</sup> for machine learning pipelines, and digital engineering.<sup>10</sup>
- *Software.* Federated software architecture<sup>11</sup> linking distributed repositories hosted across the Department by mission components, their software factories, and service labs, making software discoverable through a catalog.<sup>12</sup> Includes AI algorithms, data analysis tools, and tools supporting test and evaluation, verification and validation (TEVV)<sup>13</sup> as well as processes and tools to support continuous Authorization to Operate (ATO) frameworks and reciprocity.<sup>14</sup>

- **Data.** Federated and secured data architecture linking distributed repositories across the department hosted by mission components, service labs, and enterprise programs, making data discoverable through a catalog.<sup>15</sup> With appropriate access controls, this will facilitate finding, accessing, and moving desired data across the Department<sup>16</sup> including data sets, associated data models, and trained AI models along with supporting documentation.<sup>17</sup>
- **Hardware Infrastructure.** Networking and communications backbone to transport ecosystem resources, particularly data, and provide seamless access and interchange between cloud computing and storage services.

AI Digital Ecosystem.



To accelerate the process of building on existing resources and pathfinder efforts, and to increase interoperability in the short term, DoD should determine a governance structure and develop necessary policies and guidance, draft a reference design, and make the technical investments in the network and in platform environments. Implemented correctly, the digital ecosystem will ensure force-multiplying common access and interoperability. The Blueprint for Action framework outlined below marries top-down coordination and direction with bottom-up mission implementation to realize an enterprise-wide ecosystem in a manner that does not slow or stymie innovation, but rather incorporates new capabilities at the speed of innovation and mission requirements.

Actions for the Department of Defense:

- **Establish Digital Ecosystem Leadership and Governance.**

- o The Secretary of Defense should direct the establishment of an enterprise-wide digital ecosystem to support capability development to maintain the technological superiority of the United States military.
  - To ensure senior leader oversight and sustained resourcing, the Secretary should assign the Steering Committee on Emerging Technology the responsibility to oversee the implementation and sustainment of the ecosystem.
  - The Secretary should assign the DoD Chief Information Officer (CIO) as the Executive Agent responsible for the ecosystem design, development, and operation.
- o The Steering Committee on Emerging Technology, coordinating with the DoD CIO, DoD Comptroller, Director of Cost Assessment and Program Evaluation, and appropriate acquisition and programming representatives from the military services, should produce a funding plan<sup>18</sup> for the ecosystem within 90 days of the Secretary's direction.
- o The DoD CIO should form and chair an enduring digital ecosystem implementation working group<sup>19</sup> to establish and maintain an open architecture, an evolving reference design, governance structure, and processes to include management and authorization for ecosystem functions and growth. The Steering Committee on Emerging Technology will ensure strategic direction and coordination, and pathfinder organizations will provide bottom-up and mission-oriented implementation.<sup>20</sup>
  - The working group should report to the Steering Committee on Emerging Technology, add members when appropriate, and include representatives from:<sup>21</sup>
    - The Office of the DoD Chief Data Officer (CDO)
    - Component CIOs and CDOs
    - The Joint Artificial Intelligence Center (JAIC)
    - The Office of the Under Secretary of Defense for Research & Engineering (OUSD (R&E))

- The Office of the Under Secretary of Defense for Acquisition & Sustainment (OUSD (A&S))
  - The Office of the Under Secretary of Defense for Intelligence & Security (OUSD (I&S))
  - Service Acquisition Executives
  - The Office of the Director of Operational Test and Evaluation (DOT&E)
  - The Director of the Defense Advanced Research Projects Agency (DARPA)
  - Digital ecosystem pathfinders, including but not limited to, the Air Force's PlatformOne, Kessel Run, Space CAMP, the Navy's Black Pearl, the Army's CReATE, ADVANA, and the Army Futures Command Software Factory<sup>22</sup>
- **Develop and Mandate Participation in a Digital Ecosystem Governed by an Open Architecture and Reference Design.**
    - o Within 12 months of the Secretary's direction to establish the ecosystem, the DoD CIO should work with the implementation working group to develop and publish an open, interoperable architecture<sup>23</sup> built on common interfaces based on industry-standard protocols along with an evolving reference design.<sup>24</sup>
      - The open architecture and reference design should be owned by the DoD CIO and reviewed quarterly and updated through the working group.
      - An unclassified version of the open architecture and reference design should be published publicly for commercial capability providers.
    - o The Secretary of Defense should issue a memorandum that requires all new joint and service programs to participate in the digital ecosystem and adhere to the open architecture.<sup>25</sup> This should include a requirement that all existing programs develop a plan to participate and become interoperable with the digital ecosystem wherever possible by 2025.
      - Through the Joint Requirements Oversight Council (JROC), the Vice Chairman of the Joint Chiefs of Staff (VCJCS) and USD (R&E)<sup>26</sup> should ensure that all joint and service programs designed to meet joint capability needs adhere to the digital ecosystem open architecture.<sup>27</sup>
    - o The DoD CDO, acting in coordination with the DoD Data Council, should ensure that the Data Strategy Blueprints for Action Annex developed by each Component under the DoD Data Strategy adhere to the digital ecosystem open architecture.
    - o The USD (A&S) should update the guidance governing the formatting requirements for deliverable data in contracts to be well-documented,<sup>28</sup> "non-proprietary formats designed for interoperability."<sup>29</sup>
    - o The Steering Committee on Emerging Technology should lead an effort with the IC to assess additional ways to accelerate implementation and leverage the digital ecosystem, including designating service providers to proliferate applications across the enterprise and make them available for integration into complex mission solutions.<sup>30</sup> Wherever possible, the digital ecosystem's open architecture should leverage and interoperate with proven solutions from the IC such as the Information Technology Environment recommended in Chapter 5 of this report.

- **Establish a Strategic Data Node.**

- o The DoD CDO should make it a priority to create a linked, large-scale, cloud-based data repository (i.e., a node within the digital ecosystem) adherent to the data service interfaces specified in the ecosystem's open architecture. This would be a critical step to enable distributed development efforts by providing AI development teams secure access to authoritative data from diverse mission sets and functional areas, and serve as a prototype for the digital ecosystem reference design.<sup>31</sup>
  - The CDO should create this strategic data node by integrating digital ecosystem interoperability into the DoD ADVANA system<sup>32</sup> and prioritize construction of enterprise data sets as recommended below.

- **Expand the Network and Communications Backbone to the Digital Ecosystem.**

- o The Department should fully fund its network and communications modernization effort as outlined in the DoD Digital Modernization Strategy,<sup>33</sup> require the DoD CIO to factor this into their list of highest priorities, and hold the DoD CIO accountable for expediting critical upgrades.

- **Create a Marketplace to Promote Democratization of AI Building Blocks.**

- o The DoD CIO, in accordance with the digital ecosystem governance and reference design addressed above, should create an AI marketplace for strategic exchanges of the essential AI building blocks.<sup>34</sup> The marketplace should include:
  - SoftEx — GitLab-like<sup>35</sup> software repository system<sup>36</sup> hosting AI algorithms, TEVV tools,<sup>37</sup> hardened AI software stacks, etc.
  - DataEx — a federated data repository system<sup>38</sup> of AI-ready data sets, documentation, and associated data models.<sup>39</sup>
  - ModelEx — a federated repository system of trained models<sup>40</sup> generated from various types of AI approaches and techniques, including statistical machine learning.<sup>41</sup>
  - CloudEx — a cloud-agnostic, networked marketplace for pre-negotiated computing and storage services from a pool of vetted cloud providers.<sup>42</sup>
- o Trusted partners (inside and outside government) should be able to develop solutions and products within secured environments of the ecosystem, offering monetized access to users.<sup>43</sup>

- **Develop Prototypical Platform Environments within the Digital Ecosystem.**

- o The DoD CIO should work closely with the digital ecosystem pathfinder community to build a set of tailorable development environments for training AI systems using: data-driven statistical machine learning; the latest simulation and modeling capabilities to support reinforcement learning (e.g., digital twinning within an accurate world model); and complementary TEVV services.<sup>44</sup>
- o The DoD CIO should work closely with the digital ecosystem pathfinder community to implement a set of prototypical platform environments<sup>45</sup> that support development, testing, fielding, and continuous update of AI-powered applications for diverse categories of contributors and users.<sup>46</sup>

Action for Congress:

- **Prioritize funding for the Department's digital ecosystem and associated activities.**
  - o The Armed Services Committees should use the FY2022 NDAA to direct the Department to develop a resourcing plan for the digital ecosystem that establishes, sustains, and incentivizes use of its various components as enterprise-wide, enduring resources.
  - o The Committees should also authorize the obligation of funds to begin work on the ecosystem.

Recommendation

*Recommendation: Train and Educate Warfighters*

Warfighters need the following capabilities to effectively build and use AI-enabled systems:

- *Data-informed decision-making:* Data-informed decision-making uses data to generate insights and act on them. Data-driven organizations often make decisions more quickly, at lower levels in the organization, and with a stronger empirical foundation than organizations that rely primarily on intuitive or experience-based decision-making.<sup>47</sup>
- *Computational thinking:* Service members need to better understand how to use information processing agents to perform beneficial calculations that could not be done quickly or efficiently by a human, rather than just representing human thinking in a digital format.
- *Maker culture:* Service members of all ranks and occupations need regular contact with AI-enabled machines, and should be able and encouraged to experiment with and participate in the development of new tools.
- *Human-machine teaming:* Military leaders need to understand how to effectively provide input to machines, interpret machine outputs, and critically, when to trust or not trust machine outputs.<sup>48</sup>
- *Organizational transformation:* Leaders need to understand when and how to integrate AI-related tasks into their organization's priorities, allocate resources needed to build and maintain the AI stack, oversee the deployment and scaling of new systems, and how to effectively interact with and support the careers of their technical experts.

*Component 1: Integrate Digital Skill Sets and Computational Thinking into Military Junior Leader Education.*

Military junior leaders need to understand enough about AI to manage and operate AI-enabled organizations responsibly and effectively. Commanding and leading AI-driven systems and humans are very different fields. Leadership is even more complex in organizations that combine human and AI elements. The below skill sets will equip junior leaders with the fundamental skills needed.

*Problem Definition and Curation.* Military leaders need to understand problem curation, or the process of discovering the causal mechanisms that lead to problems, associated issues, stakeholders, and potential minimum viable products.<sup>49</sup> Poor problem definition

and curation can lead to projects that attempt to solve the incorrect problem, wasting significant amounts of time and money. This is particularly true for AI. Not all problems can be solved using the type of probabilistic reasoning performed by many algorithms, or with limited data sets. Also, many problems with potential AI solutions can be solved with much easier, less-resource-intensive techniques. Military leaders that understand problem curation will be better able to identify problems with potential AI solutions, and, just as importantly, problems that AI will not help solve. This would not only help with the use of AI but would also make junior leaders generally more productive.

*A Conceptual Understanding of the AI Stack.* The AI stack is a model that “provides a streamlined approach to visualize, plan, and prioritize strategic investments in commercial technologies and transformational research to leverage and continuously advance AI across operational domains, and achieve asymmetric capability through human augmentation and autonomous systems.”<sup>50</sup> A conceptual understanding of the AI stack would reinforce the importance of building structural solutions to data collection, management, curation, installation of sensors, and other underappreciated topics, and reduce attempts to add AI at the end of a project. It will also help military leaders better understand what part of their adversaries’ AI to target to degrade its effectiveness.

*Data Collection and Management.* Junior leaders need to understand how to collect and manage data and to use systems that do the same in a manner that prepares it for exploitation, and to operate in an environment where adversaries are doing the same. They also need to understand the causes, effects, and ethical implications of data bias. Training junior leaders to collect and manage data with the same degree of responsibility and expertise that they use for medical care and equipment maintenance would accelerate the government’s ability to create AI solutions, and to employ data-informed decision-making.

*Understanding Probabilistic Reasoning and Data Visualization.* Junior leaders need to know enough about probabilistic reasoning and data visualization to understand the outputs of their AI systems and their implications for a particular situation or environment. This is critically linked to understanding when to trust and not trust a system’s outputs, and other aspects of commanding and leading AI-driven systems. Notably, this does not require leaders to perform computational statistics, just to understand their output, a much less demanding task.

*Data-informed Decision-making.* To make data-informed decisions, leaders need to understand system thinking and critical thinking. System thinking combines all of the above to create an empirical but incomplete understanding of factors influencing a decision, and how both their system affects their AI and how their decision will affect their system. Critical thinking will help leaders understand the limits of AI, and the limits of data-informed decision-making processes that are based on imperfect information. This report references data-informed rather than data-driven decision-making because military leaders should never be bound by the imperfect information in front of them. Their critical

thinking, judgment, and intuitive understanding of both their system and their environment will always have a critical role to play, even as it is informed by decision-making aids.

Action for Congress:

- **Require the military services to integrate digital skills and computational thinking into pre-commissioning and entry-level training.**
  - o The Armed Services Committees should use the FY2022 NDAA to require the military services to integrate understanding problem curation, the AI life cycle, data collection and management, probabilistic reasoning and data visualization, and data-informed decision-making into existing, pre-commissioning or entry-level training for junior officers and training for non-commissioned officers within one year of the passage of the legislation.

Action for the Military Services:

- **Integrate digital skills and computational thinking into pre-commissioning and entry-level training.**
  - o The military services need to integrate understanding problem curation, the AI life cycle, data collection and management, probabilistic reasoning and data visualization, and data-informed decision-making into pre-commissioning or entry-level training for junior officers and training for both junior and senior non-commissioned officers. The military services can accomplish this by creating new modules or courses, or by integrating this training into existing training and education for commissioned and non-commissioned officers. Whenever possible, this training should include the use of existing AI-enabled systems and tools.

*Component 2: Integrate Emerging and Disruptive Technologies into Service-level Professional Military Education.*

While it is critical that military junior leaders better understand digital technology, military leaders must also understand how technology will affect warfare, their roles in their organizations, and how they should integrate new technology, both as they increase in rank and responsibility and as technology changes.

Action for Congress:

- **Require the military services to integrate emerging and disruptive technologies into service-level Professional Military Education.**
  - o The Armed Services Committees should use the FY2022 NDAA to direct the DoD to require emerging and disruptive technologies courses for officers within one year. The Armed Services Committees should also require the DoD to develop a training plan that incrementally builds the necessary skills in its officer corps.

Action for the Military Services:

- **Integrate emerging and disruptive technologies into service-level Professional Military Education.**

- o Course materials should address AI and other militarily significant emerging technologies, as identified by the military services and the USD (R&E), in coordination with the national laboratories, Federally Funded Research and Development Centers (FFRDCs), and University Affiliated Research Centers (UARCs).
- o Course materials should include an introduction to the latest technology, the benefits and challenges of adapting new technologies, how organizations successfully and unsuccessfully adopt these technologies, and ethical issues surrounding the uses of emerging technologies, including the impact of biases in these technologies.
- o As officers progress in rank, such courses should increasingly build the knowledge base, vocabulary, and skills necessary to better understand new threats/challenges, develop operational and organizational concepts, and incorporate technology into operations and operational support.
- o Military services should establish a mechanism that audits these courses annually to ensure that emerging technologies have been properly identified, and that the nomenclature, lexicon, definitions, and course content match changes in emerging technologies.

*Component 3: Create Emerging and Disruptive Technology Coded Billets in the Department of Defense.*

It is crucial that the DoD incentivize and increase the skill needed to introduce and field emerging and disruptive technologies within the military officer corps. The joint qualification process can serve as a model. The DoD already designates that certain critical billets must be filled by Joint Qualified Officers<sup>51</sup> and different levels of joint qualification.<sup>52</sup> To do this, the DoD should create emerging and disruptive technology designated billets for officers that require an emerging and disruptive technology qualification prior to assignment and a process for military leaders to become emerging and disruptive technology qualified. Emerging and disruptive technology qualified officers would add value in a number of areas for the services, including: 1) Assisting with acquisition of emerging technology; 2) Helping integrate technology into field units; 3) Developing organizational and operational concepts; and 4) Developing training and education plans.

Action for Congress:

- **Require the Department of Defense to create emerging and disruptive technology critical billets that must be filled by emerging technology certified leaders.**

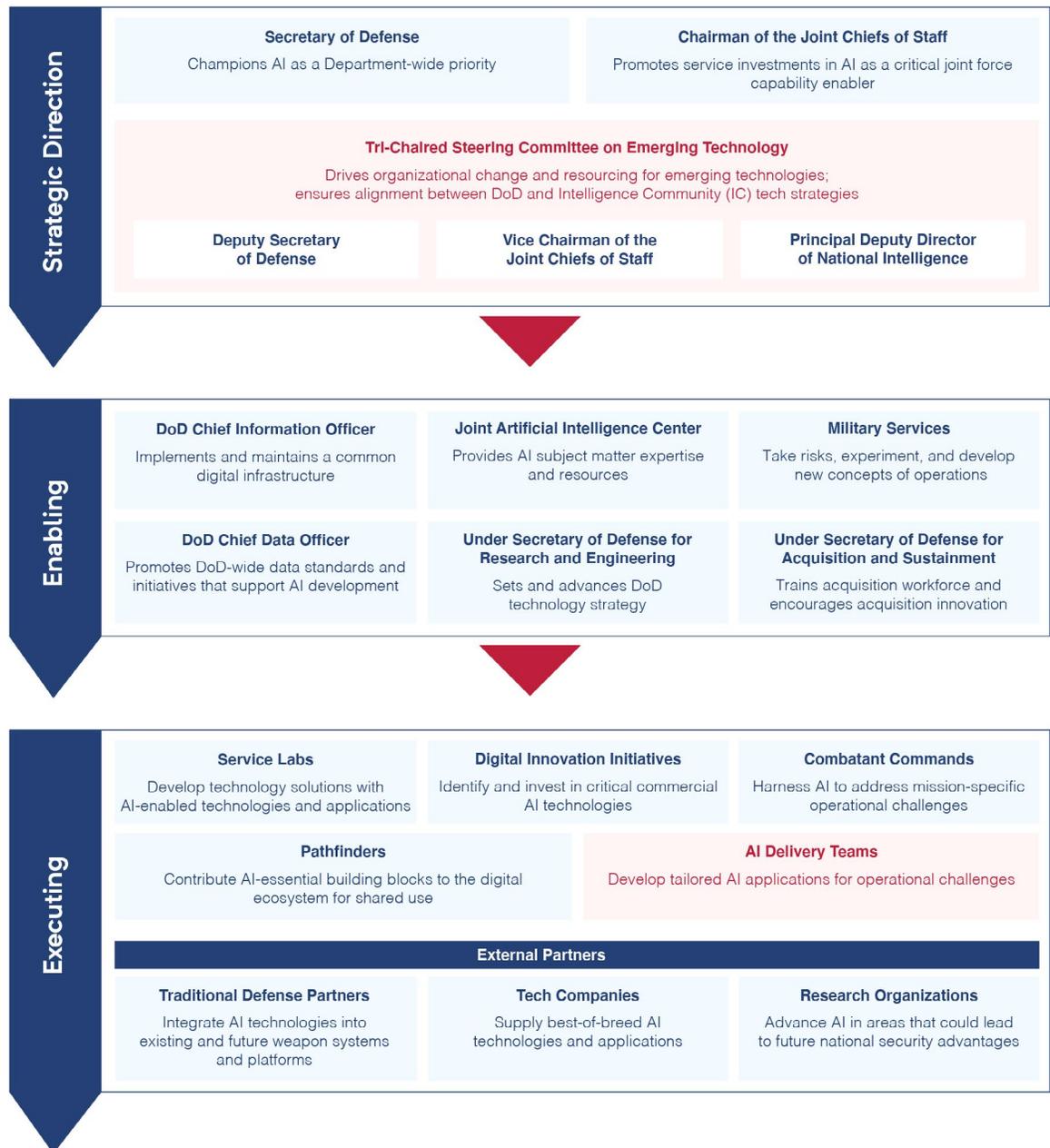
Actions for the Department of Defense:

- **Create billets that require officers to become emerging and disruptive technology certified before serving in the positions.**
  - o The Office of the USD (R&E) should define emerging and disruptive technologies.
  - o Billets include, but are not limited to, positions that develop military doctrine and/or operating concepts; positions within Force Structure, Resources, and Assessment

directorates; positions within Force Development directorates; and leadership positions at the operational and tactical levels within the military services.

- **Create a process for officers to become emerging and disruptive technology certified.**
  - o The process to become emerging tech certified would resemble the joint qualification system.
  - o Officers should become emerging technology qualified by serving in emerging technology focused fellowships,<sup>53</sup> emerging technology focused talent exchanges, emerging technology focused positions within government, and completing educational courses focused on emerging technologies.

Organizing DoD for AI Adoption.



*Recommendation: Accelerate Adoption of Existing Digital Technologies*

The Department must have an integrated approach to AI and other emerging technologies that ensures the U.S. military can continuously identify, source, field, and update capabilities faster than our competitors. This requires more targeted investment in dual-use technologies, ensuring system adaptability through a more agile budget and oversight process, and streamlining the acquisition process to shed those rules and regulations whose benefits are outweighed by the burdens imposed on the system. Critically, the Defense Acquisition System must shift away from a one-size-fits-all approach to measuring value from the acquisition process. Adherence to cost, schedule, and performance baselines is rarely a proxy for value delivered, but is particularly unsuited for measuring and incentivizing the iterative approaches inherent in AI and other software-based digital technologies. Unless the requirements, budgeting, and acquisition processes are aligned to permit faster and more targeted execution, the U.S. will fail to stay ahead of potential adversaries.

*Component 1: Adopt Proven Commercial AI Applications for Core Business Processes.*

Commercial AI applications for business processes can generate labor and cost savings, speed administrative actions, and inform decision-making with superior insights. To realize these benefits, DoD should initiate the digital transformation of its core administrative functions.

Efforts to apply business AI depend on the availability of clean, organized data. Significant resources are required to access, clean, and label enterprise data from the range of legacy business platforms.

DoD should create opportunities for bottom-up identification of AI use cases by incentivizing DoD organizations to deploy proven commercial applications tailored to their specific mission needs. Promising categories of commercial AI include: 1) Knowledge management applications such as intelligent search tools that index, retrieve, and display an agency's digital information, as well as collective intelligence and coaching tools that accumulate and exchange tacit knowledge across an agency's workforce; 2) AI-enabled tools that analyze business information to identify patterns, develop insights, and inform decision-making; and 3) Robotic Process Automation (RPA) tools including desktop assistants, bots, and other personal productivity applications that automate individual office functions.

Actions for the Department of Defense:

- **Prioritize construction of enterprise data sets across core DoD business administration areas.**<sup>54</sup>
  - o The Deputy Secretary of Defense should:

- Assign the DoD CDO responsibility for working with institutional stakeholders to develop enterprise data sets for human resources, budget & finance, acquisition, logistics, retail, real estate, and health care.
  - Place special priority on the CDO building an enterprise data set that supports portfolio management of investments in emerging technologies, spanning budget requests, acquisition, contracting, and invoicing.<sup>55</sup>
  - Assign the JAIC to support the DoD CDO in developing new methods for generating higher quality data for each core business administration area at the point of origin. This would include applying data tags that allow AI-enabled cross domain analyses.<sup>56</sup> As part of this effort, the JAIC should also look to develop or procure AI tools that continuously extract tagged information for analysis from enterprise data sets.
  - Ensure sufficient funding is included as part of the FY2023 budget request to provide data engineering services.
- The Secretary of Defense should issue a department-wide directive mandating the review and streamlining of policies and regulations wherever possible to increase and accelerate data sharing across agencies, with proper protections, building on the JAIC's Gamechanger AI prototype<sup>57</sup> to analyze and modernize the framework within which data access rules are enforced.
- **Launch a department-wide initiative to incentivize rapid deployment of commercial AI solutions for business functions.**
  - The Deputy Secretary of Defense should assign the JAIC, in its role as the Department's AI accelerator,<sup>58</sup> to administer allocation of matching funds, monitor and assess results, and disseminate best practices and lessons learned for the deployment of AI solutions for knowledge management, business analytics, and RPA across the Department, defense agencies, Services, and Combatant Commands.<sup>59</sup>
  - The Secretary of Defense should issue a DoD directive mandating added flexibility and/or streamlining of policies and regulations wherever possible to increase and accelerate acquisition and deployment of commercial AI software, building on the JAIC's Gamechanger AI prototype to analyze and modernize the existing rules framework.<sup>60</sup>
  - The Deputy Secretary of Defense should establish a \$100 million fund under the management of the JAIC to accelerate procurement and integration of commercial AI solutions for business applications. This would be used to provide matching incentive funds for agencies contracting with commercial AI vendors with approved solutions. The Deputy Secretary should also:
    - Consider leveraging the defense-wide review process detailed below to identify and reprogram sufficient funds to stand-up this fund by the beginning of FY2022.
    - Ensure sufficient funding is included as part of the FY2023 budget request to sustain the fund.

Action for Congress:

- **Congress should provide \$125 million as part of the FY2023 defense appropriations act for developing enterprise-wide data sets, and \$100 million for the fund to accelerate procurement and integration of commercial AI solutions for DoD business functions.**

*Component 2: Network Digital Innovation Initiatives to Scale Impact.*

Too often the Department's enthusiasm for innovation comes at the expense of impact and scale. Dozens of innovation offices across the Department and Services develop, transfer, and apply cutting-edge technology for national security uses.<sup>61</sup> However, many of the initiatives that are focused on bridging the gap with the technology sector, to include AFWERX, NavalX, Army Applications Laboratory (AAL), and the Defense Innovation Unit (DIU), operate in silos and are limited in their ability to scale solutions. These pockets of successful bottom-up innovation have achieved some promising results, but disparate activities cannot translate to strategic change without top-down leadership to synchronize efforts and overcome organizational barriers.<sup>62</sup> The Department should "network" programs that work to source cutting-edge technology solutions under the banner of "digital innovation initiatives" to execute a "go-to-market strategy" for digital technology that is supported at the highest levels of the Department.

Actions for the Department of Defense:

- **Designate an Executive Agent to coordinate the Department's digital innovation initiatives.**
  - o The Secretary of Defense should designate USD (R&E) as Executive Agent for the Department's digital innovation initiatives<sup>63</sup> and direct that USD (R&E) to coordinate closely with USD (A&S), DoD CIO, and DoD CDO to carry out the responsibilities associated with this role.<sup>64</sup>
  - o As Executive Agent, USD (R&E) should facilitate access to resources,<sup>65</sup> provide strategic guidance, and offer other forms of institutional support to enable innovation organizations to execute their current mandates more effectively, without infringing on autonomy or inhibiting bottom-up experimentation.<sup>66</sup> USD (R&E) should work with the DoD CIO, the DoD CDO, and USD (A&S) as well as other institutional stakeholders as appropriate, to:
    - Develop a common digital platform for digital innovation initiatives to share data and procurement and development best practices,<sup>67</sup> track ongoing projects, connect with DoD program offices, and identify other means of collaboration.
    - Harness business AI tools to eliminate stovepipes and gain shared understanding of the digital innovation community, including investments and customers.<sup>68</sup>
    - Identify and implement other metrics for the digital innovation initiatives to report as necessary, so long as they are lightweight and automated to the maximum extent possible.

- **Develop a “go-to-market” strategy for digital technology.**

- o USD (R&E) and USD (A&S) should issue a joint memo outlining a “go-to-market” strategy for digital technology to guide innovation organizations to pursue common objectives, based on the Technology Annex described below. This approach would coordinate efforts for effect and reduce duplication of effort, while preserving room for trial and experimentation with unexpected technologies or applications that could inform new operational concepts.<sup>69</sup>
- o The Department should back this strategy with significant resources and top-down support. As described further in Chapter 11 of this report, DoD should set a target of increasing its contracts with early-stage technology firms by four times over the five-year Future Years Defense Program. To meet this goal, the Department should increase the procurement budgets of innovation organizations and other DoD entities to which innovation organizations hand off successful prototypes for production, as appropriate.
- o USD (R&E) should conduct annual investment portfolio reviews of digital innovation initiatives to assess alignment with strategy<sup>70</sup> and report findings to the Steering Committee on Emerging Technology.

- **Optimize operations to enable transition and scaling of AI solutions.**

- o USD (R&E), in partnership with USD (A&S), should assist innovation organizations in providing contracted vendors access and resources to build, deploy, and assure AI solutions often and at scale.<sup>71</sup> In developing vendor contracts and planning customer journeys, digital innovation initiatives should consider the methods and means to:
  - Ensure that data access and data security requirements are included in contracts for AI systems that depend on data for training or operations.
  - Provide consistent access to end users as part of AI development processes and throughout the life cycle of the AI algorithm; and capture in contract terms.
  - Include AI testing and evaluation consideration as part of every development agreement.
  - Dedicate people and processes to onboard non-traditional vendors, migrate them onto the right networks and sandbox environments, and assist them in securing ATO.<sup>72</sup>
  - Connect prototype contract recipients with DoD customers early in the technology development process and match program dollars with additional funding (SBIR, dedicated scaling funds, etc.) wherever possible.<sup>73</sup>
  - Identify new opportunities for defense primes to team with non-traditional firms to adopt AI capabilities more quickly across existing platforms.<sup>74</sup>
- o USD (R&E) should work with USD (A&S) to develop common reporting requirements to measure the impact of digital innovation initiatives, building off of ongoing efforts at DIU.<sup>75</sup> Collection of this data should be automated to the maximum extent possible and communicated routinely to Congressional defense committees. Reporting should consider:

- *Expansion of NSIB:* Number of awards made to companies with no previous DoD experience and percentage of these that receive follow-on contacts; or number of companies that receive recurring government revenue for first time and funding stability over consecutive quarters.
- *Rate of Transition:* Number of companies that receive follow-on production contracts.
- *Rate of Scaling:* Number of prototype contract recipients that reach \$10 million, \$50 million, \$100 million, \$500 million, and \$1 billion in total DoD contracts annually.
- *Reach of Products:* Number of users<sup>76</sup> that are benefiting from the product in one year, three years, 10 years, etc.
- *User Experience:* User feedback on the product (scale 1-10).
- *Company Acquisition Process Experience:* Company feedback on the new acquisition process (scale 1-10).
- *Operational/Enterprise Impact:* Actual or projected operational or fiscal return on investment (e.g., initiative addressed an operational gap; innovative RPA reduced production time or man-hours).

*Component 3: Expand Use of Specialized Acquisition Pathways and Contracting Approaches.*

AI technologies are incompatible with the lengthy, linear processes typical of traditional DoD capabilities acquisition.<sup>77</sup> Recent policy reforms such as the rollout of the Adaptive Acquisition Framework<sup>78</sup> (AAF) and associated resources—such as the Contracting Cone<sup>79</sup>—are positive steps to move the Department away from a “one-size-fits-all” approach to acquisition. However, use of the specialized pathways and authorities<sup>80</sup> within the Framework is inconsistent and disincentivized.<sup>81</sup> The traditional acquisition process remains the default for most acquisition professionals—many of whom are neither incentivized nor properly equipped to make use of the full resources at their disposal through the Framework.

To accelerate delivery of AI-enabled technologies to the warfighter and increase their operational relevance, DoD must build the capacity to use the full breadth of acquisition pathways and contracting approaches.<sup>82</sup> Acquisition professionals must have a sufficient understanding of digital and emerging technologies in order to thoughtfully apply these tools. Given the speed of advancements in AI and other software-based technologies, this requires a shift to a continuous learning mindset and a different approach to training for acquisition professionals in which the target metric for success is not course completion, but rather the ability to apply what is learned and impact mission outcomes. DoD should coordinate acquisition workforce training initiatives relative to digital and emerging technologies ongoing across the Department and continuously assess acquisition workforce capability needs. Importantly, the DoD must also ensure acquisition personnel have common access to available digital technology courses and best practices as well

as a community of experts that illustrate how specialized authorities can be used to deliver best of breed technologies.

Actions for the Department of Defense:

- **Accelerate training of acquisition professionals and senior leaders on the AAF, Contracting Cone, and Digital Technologies.**
  - o The Secretary of Defense should develop a set of best practices in the use of new acquisition pathways<sup>83</sup> and direct USD (A&S) and Component Acquisition Executives to train the right acquisition professionals and DoD senior leaders and executives on the AAF, the Contracting Cone, and best practices for the use of these flexibilities, within one year.
  - o USD (A&S) should also work closely with USD (R&E), the JAIC, the Service Acquisition Executives, and the Component Acquisition Executives to implement a coordinated approach to training acquisition professionals and senior leaders on cross-functional specialties relative to emerging technologies. The approach should amplify and harmonize ongoing workforce training efforts<sup>84</sup> related to AI, data analytics, software, and digital engineering and look to leverage training or courses that can be procured off-the-shelf or as a service.
- **Leverage public-private talent exchanges to infuse technical expertise into the acquisition corps.<sup>85</sup>**
  - o The Secretary of Defense should direct that acquisition professionals are considered among the highest priority to participate in public-private talent exchanges.<sup>86</sup>
- **Establish enterprise learning platforms, course catalogs, and knowledge management tools for acquisition personnel and make them available Department-wide.<sup>87</sup>**
  - o USD (A&S) should invest in and scale appropriate learning platforms, course catalogs, and knowledge management tools and create incentives for their use by FY2022. These resources should catalog available training<sup>88</sup> and best practices<sup>89</sup> and make relevant experts and specialists discoverable for acquisition professionals Department-wide.
- **Continuously assess existing acquisition workforce capabilities and evolve training for acquisition professionals.**
  - o The Secretary of Defense should direct that USD (A&S) work with the Service Acquisition Executives, Component Acquisition Executives, USD (R&E), and the JAIC to ensure curricula and approach to training<sup>90</sup> for acquisition professionals is consistently and appropriately updated to support the Technology Annex to the National Defense Strategy, as described below.

Action for Congress:

- **Authorize the use of a rapid contracting mechanism for the software acquisition pathway.**
  - o The Armed Services Committees should direct the Secretary of Defense to develop a rapid contracting mechanism to support the AAF's software acquisition pathway.<sup>91</sup> The mechanism should include:

- A value-based price evaluation model.
- An independent, non-advocate cost estimate developed in parallel with engineering and leveraging agile cost estimation best practices.
- Performance metrics intended to measure value that can be automatically generated by users and shared as requested by DoD officials and congressional defense committees.

*Component 4: Modernize the Budget and Oversight Processes for Digital Technologies.*

The DoD's budget process requires that funds be requested two years in advance of their execution and focuses planning within the five-year Future Years Defense Plan (FYDP). Resources are allocated to program elements (PEs) that are defined at the system level<sup>92</sup> and based upon cost buildups for pre-determined and highly specified system requirements.<sup>93</sup> In addition, the life-cycle-phased appropriation categories<sup>94</sup> that govern the DoD budget structure run counter to the iterative process inherent to AI and other software-based technologies.<sup>95</sup>

This construct creates a paradigm unfriendly to the speed, adaptation, risk-taking, and joint force cohesion necessary to compete in an AI-enabled threat environment. Senior leaders champion the need to experiment<sup>96</sup> and “fail fast,” but the budget process prevents the allocation of funds without a justification clearly tied to program objectives. At the same time, the DoD requirements process—responsible for formulating the basis of those program objectives—assumes a linear and sequential relationship between requirements and technology.<sup>97</sup>

To adapt faster than our adversaries, DoD must have a requirements and budget process that: 1) Prioritizes joint force capabilities and aligns resources accordingly; 2) Enables experimentation, iteration, and continuous development—especially for AI and digital technologies where persistent user feedback is critical; and 3) Balances speed, scale, and risk depending on the technology or capability being delivered.

Implementation of the large-scale institutional changes required to achieve this vision will take time and equal commitment from both DoD and Congress. In the near term, DoD and Congressional leaders should focus on generating mutual trust by establishing pilot programs to demonstrate the impact of reforms to the budget and requirements process relative to AI. The inclusion of support for the Department's Budget Activity 8 pilot program in the FY2021 defense authorization and appropriations acts represents positive progress to this effect.<sup>98</sup>

Below are recommended steps that DoD and Congress should take immediately and over the longer term to create a modern budget and requirements process that supports the application of AI at speed and scale.

Immediate Actions for the Department of Defense:

- **Reorient the Joint Requirements Oversight Council (JROC) process to focus on Joint and Cross-Domain Capability.**
  - The Chairman of the Joint Chiefs of Staff should appoint the USD (R&E) Co-Chair and Chief Science Advisor of the JROC.<sup>99</sup>
  - The Chairman of the Joint Chiefs of Staff should direct that the JROC charter be updated to reflect USD (R&E) as Co-Chair and Chief Science Advisor with responsibility for:
    - Delivering technology assessments and trend reports that inform JROC deliberations on future military requirements; and
    - Validating the technical feasibility of requirements developed by the services and ensuring they comply with the reference design for the digital ecosystem recommended above.
- **Make supplemental funding available to drive operational prototyping, scale, and transition of AI technologies.**
  - The Secretary of Defense should establish a dedicated AI fund as a pilot under the management of USD (R&E) to mature, operationally prototype, and transition exceptionally promising AI-enabled technologies that align with applications identified in the Technology Annex as described below. In doing so, the Secretary of Defense should direct:
    - Inclusion of approximately \$200 million for the fund in the FY2022 budget request.
  - USD (R&E), in collaboration with the JAIC and the military services, should establish clear metrics for success and a time horizon upon which to stand-up additional similar funds for specific technologies or capabilities.
- **Accelerate efforts<sup>100</sup> to implement a portfolio management approach for requirements and budget.**
  - The Deputy Secretary of Defense should produce a proposal for consideration in the FY2022 defense authorization and appropriation bills to establish a pilot to test a portfolio management approach for requirements and budgeting for at least one joint capability area, such as Command and Control, in FY2023.<sup>101</sup> The proposal should:
    - Establish a reasonable ceiling value for the portfolio.
    - Consider consolidation of program elements and the creation of a Program Executive Office or other organizational entity empowered to resource and oversee programs designed to meet the joint capability need.
    - Request reprogramming authority to drive a “fail fast” mentality, promote experimentation and early prototyping, and quickly integrate new capabilities.
    - Provide recommendations on adjusted reporting guidance and justification documents, including metrics and mechanisms,<sup>102</sup> that will allow Congress to conduct appropriate approval and oversight.

- o The Deputy Secretary of Defense should also produce a separate proposal to establish a pilot to test mission-focused budgeting and appropriations (e.g., a Mission Element). The proposal should be developed in coordination with a Combatant Command and organized around a high-priority operational challenge as identified by the Joint Staff. It should:
  - Consider more flexible funding mechanisms, including reprogramming authorities, applied across existing, relevant service programs to promote digital modernization and integration of AI technologies, interoperability, and new development or prototyping efforts for the specific operational challenge.
  - Provide recommendations on adjusted reporting guidance, and justification documents, including metrics and mechanisms, that will allow Congress to conduct appropriate approval and oversight.

Immediate Actions for Congress:

- **Update Title 10, Section 181 to designate USD (R&E) Co-Chair and Chief Science Advisor to the JROC.**
- **Direct the Secretary of Defense to establish the dedicated AI fund.**
  - o Congress should include a provision in the FY 2022 National Defense Authorization Act directing the establishment of an AI fund under USD (R&E) and appropriate at least \$200 million to support it as a pilot.<sup>103</sup>
- **Support the continuation of the Budget Activity 8 pilot program in FY2022 and direct the Department to add an S&T project to the pilot programs.**
  - o Congress should continue to support the DoD software and digital technologies pilot program designed to allow for flexibility in funding the full life cycle of development, procurement, deployment, assurance, modifications, and continuous improvement for digital technologies.<sup>104</sup>
  - o Congress should support DoD expanding the pilot in FY2022 to include a program that explicitly supports an S&T development effort in order to effectively test the impact of the single funding mechanism for the entirety of the AI life cycle, including early-stage research and development.

Longer-term Actions for the Department of Defense and Congress:

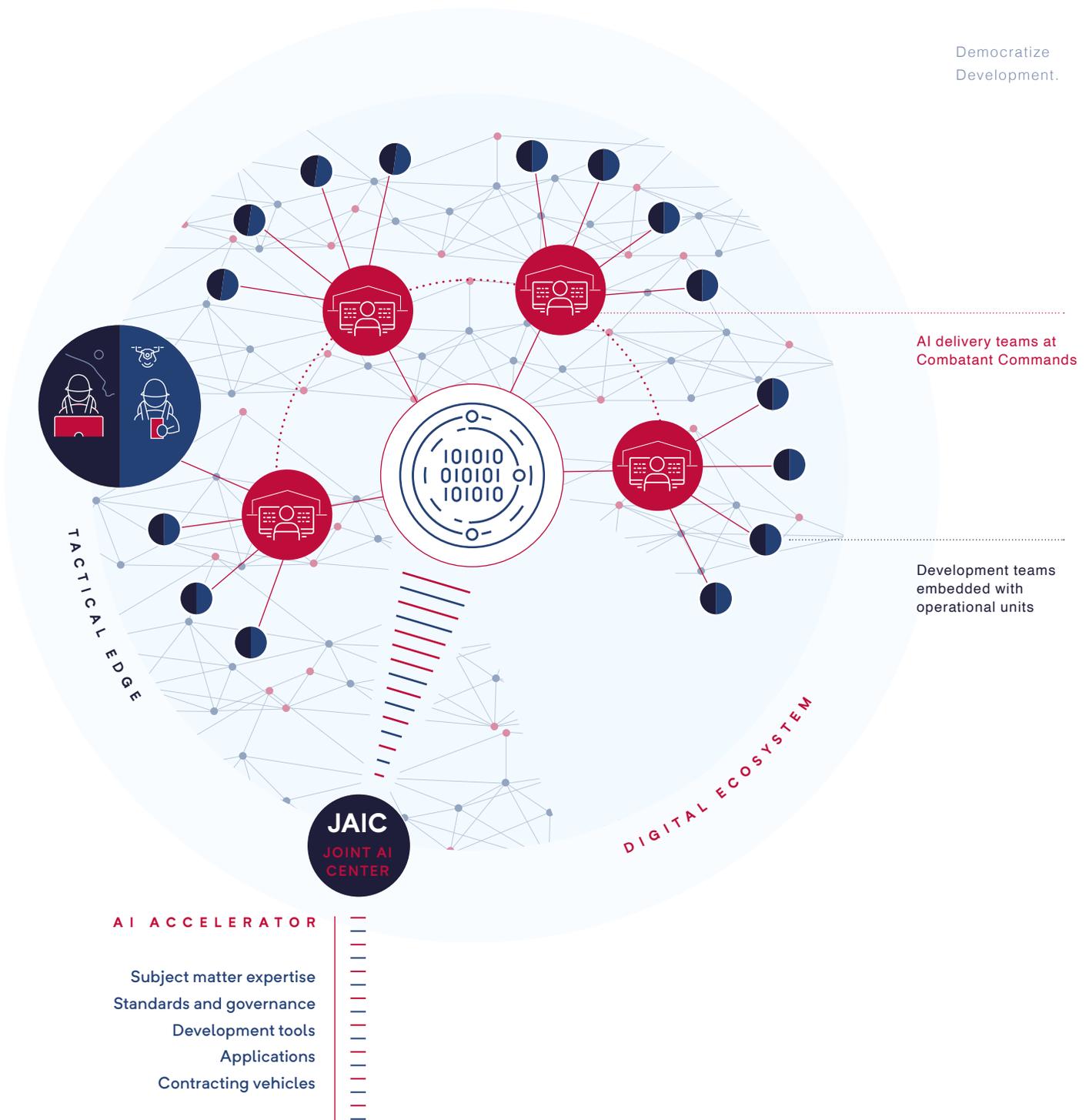
- **Establish a single appropriation and budget structure for software and digital technologies by FY2023.**
  - o Congress should build on the BA 8 pilot and establish a single appropriation for software and digital technologies that is exempt from the traditional programming or planning process and can be used as a single source of funding for the full life cycle of capability delivery and continuous engineering.
  - o The Department and Congress should collaborate to develop and implement a budget structure and transparent oversight process for the new software and digital technology appropriation that enables agile development of AI technologies and capability portfolio management.<sup>105</sup>
- **Identify and implement successful portfolio- and mission-based budgeting constructs at scale across DoD.**

- o The Department and Congress should look to BA 8 as an example of how to apply a similar approach to monitoring and scaling portfolio- and mission-based budgeting. Based on metrics and oversight of the pilots over an appropriate timeline, DoD and Congress should determine what approaches to implement more broadly.

**Recommendation***Recommendation: Democratize AI Development*

An AI-enabled threat environment requires our forces to be able to develop and deploy solutions nearly as quickly as threats arise. However, our forces frequently lack the infrastructure, tools, talent, and support to solve their challenges locally and with modern technology.<sup>106</sup> The JAIC cannot develop and proliferate AI applications for every user group or mission area within the DoD. To accelerate adoption of AI, the Department must create the technical infrastructure and organizational structures that pair top-down strategy with bottom-up development.

Democratize  
Development.



*Component 1: Leverage the JAIC as the Department's AI Accelerator.*

The JAIC should serve as the Department's "AI accelerator" and central node for AI-related information. In this role, the JAIC would maintain critical situational awareness of AI stacks across the Department (i.e., options, including applications, available within the digital ecosystem that mission owners can leverage to enable local development efforts)

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and provide the expertise and resources necessary to enable distributed development efforts.

Actions for the Department of Defense:

- **Designate the JAIC as the Department's AI Accelerator.**

- o The Deputy Secretary of Defense should issue a memorandum<sup>107</sup> designating the role of JAIC as the DoD enterprise's AI accelerator with responsibility for:
  - Developing tailorable AI applications to address high-level, cross-domain challenges and shared problems, and making them available through the digital ecosystem as enablers for development teams across the enterprise.
  - Administering a matching fund to incentivize integration of commercial AI solutions for business functions across the Department.
  - Collecting best practices (including best-of-breed AI applications) from industry, academia, and across the enterprise and making them accessible for the broader DoD developer community.<sup>108</sup>
  - Providing AI subject matter expertise and assistance to DoD Components to inform strategy, policy, and technical approaches. This would include:
    - Participating as a member of the Steering Committee on Emerging Technology.
    - Contributing to the development of a reference design for the DoD AI digital ecosystem and associated governance policies.<sup>109</sup>
    - Advising on integrating the appropriate governance frameworks for responsible use of AI into policies and procedures.<sup>110</sup>
    - Advising on TEVV policies and capabilities for AI.
    - In coordination with the Under Secretary of Defense for Policy, serving as the Department's lead for AI-related international engagement.
  - Developing a common AI TEVV framework,<sup>111</sup> in coordination with DOT&E and any other appropriate stakeholders, that integrates testing as a continuous part of requirements specification, development, deployment, training, and maintenance and includes run-time monitoring of operational behavior.<sup>112</sup>
  - Identifying, procuring, and orchestrating AI development tools and making them available through the digital ecosystem software exchange<sup>113</sup> described above to enable distributed development efforts.<sup>114</sup>
  - Making available enterprise-wide contracting vehicles (e.g., Blanket Ordering or Purchase Agreements) for talent<sup>115</sup> and AI technical services<sup>116</sup> and continuously onboarding new companies.<sup>117</sup>
  - Coordinating with USD (R&E) on AI-related elements of the go-to-market strategy discussed above.
  - Integrating with nation-wide initiatives within other agencies and departments, as directed by the President.

- **Build technical support capability.**

- o The JAIC should grow and train a staff of resident experts<sup>118</sup> that can provide support to users across the enterprise akin to an “AI help desk,” to include providing technical and policy consultation and advice; implementing solutions for small problems; and facilitating connections of support (for larger problems).<sup>119</sup>

*Component 2: Embed AI development capabilities in support of operations.*

The Department must ensure operators are paired with technologists at every echelon. Doing so will institutionalize user-centered; agile development, improve the speed and operational relevance of solutions delivered; and build trust and confidence in AI-enabled systems. Implementation of the actions below will create a networked support structure to enable bottom-up AI development extending from the tactical edge to the JAIC.<sup>120</sup>

Actions for the Department of Defense:

- **Establish integrated AI delivery teams at every Combatant Command (CCMD).**

- o The Secretary of Defense should direct each Combatant Commander to stand-up an AI delivery team dedicated to developing and deploying AI applications to support operational units.<sup>121</sup>
- o Teams should be staffed with the appropriate talent to manage the full life cycle of AI solutions, including in disciplines such as data science, AI testing and model training, software engineering, product management, and full stack development.<sup>122</sup> AI Delivery teams should be responsible for:<sup>123</sup>
  - Finding, tailoring, and fielding applications from the digital ecosystem (e.g., those developed by other CCMDs, Service software factories, or the JAIC).
  - Developing additional sustainable mission applications as needed.
  - Contributing new and tailored applications to the digital ecosystem for use across the CCMD(s) to meet common challenges.

- **Integrate forward-deployed development teams with operational units.**

- o Each Combatant Commander should develop and implement a plan for the integration of forward-deployed development teams to act as the local customer interface for the AI delivery team with each operational unit.<sup>124</sup> Forward-deployed development teams should:
  - Work side-by-side with warfighters to identify problems and opportunities that could be met with AI applications.
  - Leverage the digital ecosystem to provision development environments and tools to produce “quick wins” to improve capabilities and generate efficiencies.<sup>125</sup>

## Recommendation

*Recommendation: Invest in Next Generation Capabilities*

The DoD must have an enduring process that clearly identifies, prioritizes, resources, and tracks<sup>126</sup> critical technologies over multiple time horizons. This will drive an investment strategy that pursues technology applications that close key capability gaps and optimize current operational concepts, and simultaneously makes bets on disruptive technologies to enable transformative capabilities and operational concepts over the long term.

*Component 1: Increase investments in Science & Technology (S&T) and AI R&D.*

To compete and win in AI-enabled warfare, the propagation of technology from core AI research to broad AI applications must expand drastically.<sup>127</sup> Across the board, increases in all lines of AI research<sup>128</sup> are called for, with particularly large increases in research funding required to advance key areas, such as developing methods for human-machine teaming and deploying trusted AI applications through rigorous methods for TEVV.

Action for the Department of Defense:

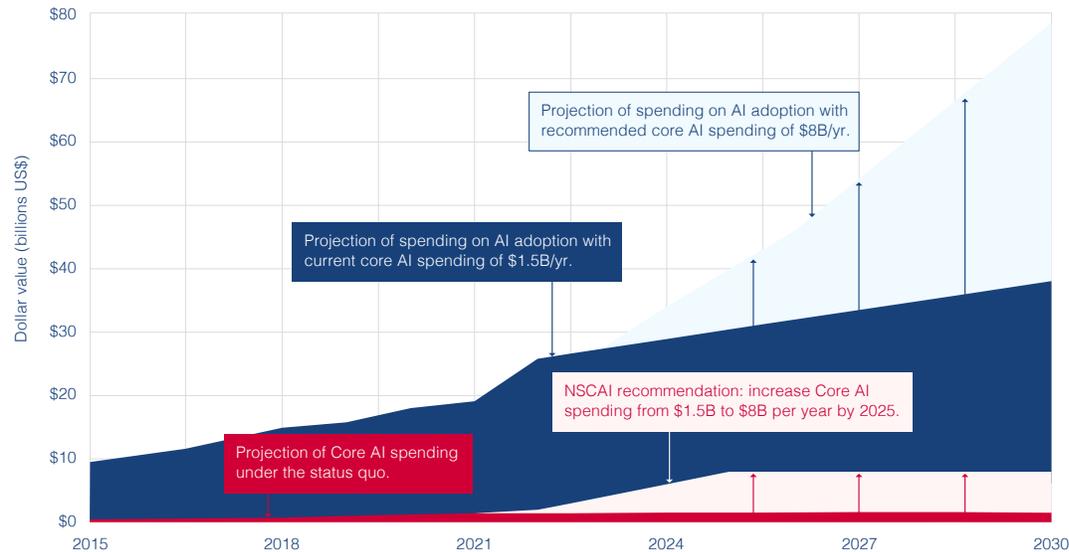
- **Commit to building budgets that invest at least 3.4%<sup>129</sup> of the annual DoD budget in S&T and allocate at least \$8 billion for research and development of core AI.**
  - o Particular focus should go toward strengthening the AI research budgets at organizations where AI expertise is centered, such as DARPA, the Office of Naval Research, the Air Force Office of Scientific Research, the Army Research Office, and the Service Laboratories.

Action for Congress:

- **Support DoD budget requests for amplified funding of AI R&D and AI-related initiatives.**

### Enhanced AI R&D Investment, FY 2015–2030

Source: Govini and NSCAI



Enhanced AI R&D Investment, FY 2015-2030.

Core AI spending is comprised of RDT&E programs to develop AI applications such as machine learning/deep learning, collaborative behavior, computer vision; human-machine teaming, automated reasoning, robotic autonomy, automated data fusion, and self-healing networks. Together with commercially sourced AI applications, core AI spending enables AI adoption. We define AI adoption as the sum of AI-enabled and AI-enabling investments (defined below).

AI-enabled programs develop (in the case of RDT&E programs) and field (in the case of procurement programs) the gamut of DoD warfighting and business systems, incorporating Core AI applications for analyzing, automating, communicating, maneuvering, monitoring, sensing, and many other tasks. While AI spending is usually a small percentage of these programs, their system’s performance may be critically dependent upon the incorporation of core AI.

AI-enabling programs include technologies such as cloud computing and advanced microelectronics required to support the deployment of effective AI capabilities at scale.

#### Component 2: Retire Legacy Systems Ill-Equipped to Compete in AI-Enabled Warfare.

In the face of new budget realities, the Department must undergo an aggressive portfolio rebalance to ensure sustained room in its budget for emerging technologies like AI.<sup>130</sup> This will require DoD to make hard decisions on where to divest, and identify opportunities and timelines to upgrade or phase out legacy systems, as it continues to invest in new systems. However, the Department must also approach new systems differently. Rather than continuing to build large, monolithic platforms while competitors invest heavily in attritable systems, the DoD should focus on speed. DoD should drive investments into rapid prototyping and modular system design to develop and field new capabilities at a rate that allows U.S. forces to continuously out-adapt the adversary.

Actions for the Department of Defense:

- **Institutionalize an enduring defense-wide review and decision-making process,<sup>131</sup> prioritized to the threat, to divest of legacy systems.**
  - o The Secretary of Defense should direct the Service Secretaries, USD (A&S), the Defense Agencies, and DoD Field Activities to evaluate the relevance and resiliency of all platforms and systems against emergent threats, and ruthlessly divest from systems and platforms deemed too costly or ineffective to equip with AI or make compatible with AI-enabled systems and architectures.<sup>132</sup>
  - o The Service Secretaries and USD (A&S), in comparing the risk/reward tradeoffs between new versus old technologies and operating concepts, should leverage AI technologies as decision support tools.
  - o The Director of CAPE should enforce decisions to divest or reduce funding through the program review process.
  - o The Service Secretaries and USD (A&S) should explore options for updating legacy systems with leading-edge technologies to buy time for required long-term modernization projects.
- **Evaluate AI alternatives prior to funding new major defense acquisition programs.**
  - o The Secretary of Defense should issue a memorandum directing that all new major defense acquisition programs must conduct a thorough evaluation of AI alternatives as part of their analysis of alternatives prior to funding for major defense acquisition programs.<sup>133</sup>
  - o USD (R&E) and the JAIC should provide support to program offices conducting such analysis by providing subject matter expertise informed by technology scouting and an awareness of the capabilities in the R&D pipelines across the S&T enterprise.

Action for Congress:

- **The Congressional defense committees should support the Department's hard decisions when presented with evidence that divestment or defunding can enable a more competitive force posture.**

*Component 3: Create an integrated technical intelligence program<sup>134</sup> and a supporting community of practice.*

To effectively leverage scientific and technological breakthroughs for competitive advantage, DoD must have a sophisticated technical intelligence program that monitors developments as they progress from basic research to prototype to fielded capabilities, understanding the R&D roadmaps of the private sector wherever possible. This intelligence must be global in scale, monitoring emerging technologies in near real time, especially in the rapidly evolving field of AI. The intelligence must be actionable, informing prioritization of resourcing and providing decision-makers the ability to continuously update technology roadmaps for our national security agencies.

Such a technical intelligence program should provide inputs to the proposed Technology Annex to the National Defense Strategy<sup>135</sup> in three main areas: 1) An understanding of the current and future threat capabilities in the R&D, production, and sustainment pipelines of our adversaries; 2) An understanding of the current and future friendly capabilities in the R&D, production, and sustainment pipelines of the U.S. government and allied partners; and 3) An understanding of emerging military and dual use technologies worldwide available for integration into national security capabilities.<sup>136</sup>

Actions for the Department of Defense:

- **Transform the Strategic Intelligence Analysis Cell.**

- o USD (R&E) should reconceive the Strategic Intelligence Analysis Cell (SIAC)<sup>137</sup> as a robust analytic hub that marshals DoD, IC, and other technology scouting capabilities for strategic effect.<sup>138</sup> The SIAC Director should report directly to the USD (R&E).
- o SIAC should convene an interagency technology scouting community of practice from the service laboratories, OSD (including DARPA and DIU), innovation initiatives within the military services (such as AFWERX and AAL), the Departments of Energy and Homeland Security, university-affiliated research centers, federally funded research and development centers, CCMDs, and international security partners. This community of practice should:
  - Establish a federated approach to provide USD (R&E) with inputs to produce and continuously update the Technology Annex.
  - Conduct analytic exchanges and wargames to assess future technology scenarios and include AI to the maximum extent possible.<sup>139</sup>
  - Develop rigorous technology forecasting capabilities, leveraging best practices from academia and the private sector.
  - Engage with industry and update requirements for technology scouting tools and data.
- o In order to leverage private industry more effectively, SIAC should maintain knowledge of private market investments relevant to the technologies and capabilities outlined in the Technology Annex.
- o In order to locate existing DoD capability gaps and potential solutions, SIAC must receive technical details at all levels of classification on current programs of record from OSD (A&S) and the armed service's acquisition executives, as well as technical details on RDT&E programs from OSD (R&E) and the technology scouting community of practice described above.
- o SIAC should establish a technology fellows program, inviting organizations in the technology scouting community to nominate personnel for short-term (three- to 12-month) assignments with SIAC where they would work side-by-side with SIAC analysts. This program should:
  - Build interdisciplinary teams of technologists and warfighters to conduct in-depth investigations of emerging technologies, initiating direct contacts with academia and industry in addition to passive data collection.

- Circulate personnel through the tech fellows' program into key roles in experimentation and concept development activities across OSD and the military services.
  - Develop personnel with greater understanding of emerging technologies across the national security community.
  - Leverage hiring authorities from the Public–Private Talent Exchange Program and the Intergovernmental Personnel Act to include fellows from industry, academia, and other government agencies to enhance access to non–DoD research and perspectives.<sup>140</sup>
- o SIAC should acquire or develop research tools for use by the technology scouting community of practice, including AI-enabled analysis of large commercial databases, classified threat intelligence, and the technology investment portfolios of the United States Government and its allies.

Actions for Congress:

- **Congress should appropriate an additional \$10 million to USD (R&E)'s budget for the technology fellows program and AI-enabled technology scouting tools and data.**

*Component 4: Develop a Technology Annex to the National Defense Strategy.*

To identify where and how to direct scarce resources, the DoD should formulate its investment strategy as a classified Technology Annex to the National Defense Strategy (NDS) produced by the Department's Chief Technology Officer, USD (R&E). The Appendix should: 1) Identify emerging technologies and applications required to solve the operational challenges outlined in the NDS; and 2) Outline a clear plan for pursuing these technologies and applications. This plan should account for existing technologies, including dual-use commercial technologies, and drive rapid integration of these technologies to close near-term capability gaps.<sup>141</sup> The plan should also help inform the agenda for DARPA and the DoD labs, by identifying disruptive technology elements and applications that warrant longer-term, exploratory investments. Finally, the plan must take into account industry's comparative advantage in available R&D capital and include a consistent and transparent approach to messaging defense technology priorities to build and broaden the industrial base.<sup>142</sup>

Actions for the Department of Defense:

- **Develop a Technology Annex to the National Defense Strategy.**
  - o The Secretary of Defense, with support from the Director of National Intelligence, should issue a memo directing the Steering Committee on Emerging Technology to oversee the development of a comprehensive classified Technology Annex as a component of the next NDS and assign USD (R&E) as the Executive Agent responsible for producing the Technology Annex.
    - The Technology Annex should identify emerging technologies and applications that are critical to enabling specific capabilities for solving the operational challenges outlined in the NDS.

- o The Steering Committee on Emerging Technology described above should ensure that the Technology Annex sets clear guidance that drives prioritization and resourcing, while allowing enough flexibility for subordinate organizations to implement that guidance as best suits their mission. At a minimum, the Technology Annex should include:
  - Identified intelligence support requirements, including how the IC analyzes the global environment and monitors technological advancements, adversarial capability development, and emerging threats.
  - Identified functional requirements and technical capabilities necessary to enable concepts that address each challenge.
  - A prioritized, time-phased plan for developing or acquiring such technical capabilities that takes into account R&D timelines, a strategy for public private partnerships, and a strategy for connecting researchers to end users for early prototyping, experimentation, and iteration.
    - This should include roadmaps for designing, developing, fielding, and sustaining the technologies and applications to address the operational challenges outlined in the NDS.
    - These roadmaps should account for and leverage existing commercial-off-the-shelf/dual-use technologies and identify areas where defense-specific solutions are needed.
    - The roadmaps should use quantitative technological forecasting methods developed in academia and industry to identify disruptive technologies.
  - Identified additional or revised acquisition policies and workforce training requirements to enable DoD personnel to identify, procure, integrate, and operate the technologies necessary to address the operational challenges.
  - A prioritized, time-phased plan for integrating technology into existing DoD exercises that support the NDS.
  - Identified infrastructure requirements for developing and deploying technical capabilities, including data, compute, storage, and network needs; a resourced and prioritized plan for establishing such infrastructure; and an analysis of TEVV requirements to support prototyping and experimentation and a resourced plan to implement them.
  - Identified joint capability and interoperability requirements and a resourced and prioritized plan for implementation.
  - Consideration of human factor elements associated with priority technical capabilities, including user interface, human-machine teaming, and workflow integration.
  - Consideration of interoperability with allies and partners, including areas for sharing of data, tools, and operational concepts.
  - Flexibility to adapt and iterate appendix implementation at the speed of technological advancement.
- **Steward Implementation of the Technology Annex in Coordination with the Intelligence Community.**

- o The Secretary of Defense should direct the Steering Committee on Emerging Technology to steward implementation of the Technology Annex, to include coordination with the IC; and establish a reporting structure and metrics to monitor the implementation of each technology roadmap to ensure each effort is resourced properly and progressing sufficiently.
- o The Steering Committee on Emerging Technology should ensure common technical requirements are developed to align with the digital ecosystem's open architecture and are adhered to for the acquisition of emerging technologies identified in the Technology Annex. The standards should be coordinated across DoD and the IC.<sup>143</sup>
- o The Steering Committee should conduct (at least) an annual review of the Appendix and ensure that guidance, policy, and implementation evolve at the pace of technological change.

*Component 5: Clearly communicate defense technology priorities to industry.*

DoD must leverage industry's comparative advantage in available R&D capital as part of its investment strategy. To do so effectively, the Department must adopt a consistent and transparent approach to messaging defense technology priorities that enables Defense primes and non-trationals to plan and invest more to help meet DoD R&D needs, and further supports the Department's efforts to attract venture-backed companies.

Action for the Department of Defense:

- **Publish unclassified emerging technology R&D objectives to support the Technology Annex to the National Defense Strategy.**
  - o The Secretary of Defense should direct USD (R&E) to produce unclassified emerging technology R&D objectives and publish these objectives publicly. The objectives should represent an unclassified component of the Technology Annex, and be regularly updated as living documents.
    - The R&D objectives should be tied to subsets or components of priority technologies and applications on which the government envisions the private sector playing a major role in building future capabilities.<sup>144</sup> They should be communicated with an appropriate level of detail to provide current defense companies guidance to steer their internal R&D investments, communicate to startups interested in working with the government where future opportunities lie, and signal to venture capitalists where future DoD funding might flow.
    - USD (R&E) should incorporate these objectives into the go-to-market strategy, coordinating digital innovation initiatives to act as surrogates to amplify this communication, and where appropriate, execute these priorities.

- o The Secretary of Defense should direct the Steering Committee on Emerging Technology to develop an appropriate approach to monitor industry-independent R&D investments to gauge the effectiveness of these efforts. This should be coordinated with the DoD Office of General Counsel and relevant industry associations.
- o OUSD (R&E) should leverage public-private exchange programs,<sup>145</sup> as well as internal technical expertise from entities like DARPA and the interagency technology scouting community, to bring both technical expertise and commercial proficiency to the effort.<sup>146</sup>

## Blueprint for Action: Chapter 2 - Endnotes

<sup>1</sup> See Chapter 9 of this report and its associated Blueprint for Action for a recommendation to establish a Technology Competitiveness Council that could serve as a body for this kind of strategic-level coordination.

<sup>2</sup> This action is mirrored in the Chapter 3 and Chapter 5 Blueprints for Action. The Commission acknowledges section 236 of the FY2021 National Defense Authorization Act, which permits the Secretary of Defense to establish a steering committee on emerging technology and national security threats composed of the Deputy Secretary of Defense; the Vice Chairman of the Joint Chiefs of Staff; the Under Secretary of Defense for Intelligence and Security; the Under Secretary of Defense for Research and Engineering; the Under Secretary of Defense for Personnel and Readiness; the Under Secretary of Defense for Acquisition and Sustainment; the Chief Information Officer; and such other officials of the Department of Defense as the Secretary determines appropriate. However, the structure described in section 236 does not include leadership from the Intelligence Community, and will thus not drive the intended action. See Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021), <https://docs.house.gov/billsthisweek/20201207/CRPT-116hrpt617.pdf>.

<sup>3</sup> The Commission's recommendation for the development of a Technology Annex to the National Defense Strategy is discussed later in this blueprint.

<sup>4</sup> For example, the DoD's Joint AI Center (JAIC) is building a Joint Common Foundation (JCF) that aims to provide policies and tools that support an enterprise cloud-enabled AI environment. See *About the JAIC*, JAIC (last accessed Feb. 2, 2021), <https://www.ai.mil/about.html>. Other digital ecosystem pathfinders include, but are not limited to, Platform One, Kessel Run, Space CAMP, Black Pearl, CReATE, ADVANA, and the Army Futures Command Software Factory.

<sup>5</sup> See DoD Digital Modernization Strategy, U.S. Department of Defense at 30, 42-43 (July 12, 2019), <https://media.defense.gov/2019/Jul/12/2002156622/-1/-1/1/DOD-DIGITAL-MODERNIZATION-STRATEGY-2019.PDF> (describing how the DoD plans to deploy an end-to-end identity, credential, and access management infrastructure). This is an essential function that must be implemented in an interoperable way across the national security-wide digital AI R&D ecosystem. DoD plans include a goal to "Improve and Enable Authentication to DoD Networks and Resources through Common Standards, Shared Services, and Federation." *Id.* at 30.

<sup>6</sup> Implemented as applications as a service (AaaS).

<sup>7</sup> Implemented as platforms as a service (PaaS).

<sup>8</sup> The digital ecosystem should incorporate DevSecOps processes and tools laid out in the DoD Enterprise DevSecOps Reference Design. See DoD Enterprise DevSecOps Reference Design, U.S. Department of Defense (Aug. 12, 2019), [https://dodcio.defense.gov/Portals/0/Documents/DoD%20Enterprise%20DevSecOps%20Reference%20Design%20v1.0\\_Public%20Release.pdf](https://dodcio.defense.gov/Portals/0/Documents/DoD%20Enterprise%20DevSecOps%20Reference%20Design%20v1.0_Public%20Release.pdf). For more information, see *Understanding the Differences Between Agile & DevSecOps - from a Business Perspective*, GSA (last accessed Jan. 1, 2021), <https://tech.gsa.gov/guides/understanding-differences-agile-devsecops/> ("DevSecOps improves the lead time and frequency of delivery outcomes through enhanced engineering practices; promoting a more cohesive collaboration between Development, Security, and Operations teams as they work towards continuous integration and delivery.").

<sup>9</sup> For a short primer on MLOps, see *2021 Technology Spotlight - The Emergence of MLOps*, Booz Allen Hamilton (2021), [https://www.boozallen.com/content/dam/boozallen\\_site/dig/pdf/white\\_paper/the-emergence-of-mlops.pdf](https://www.boozallen.com/content/dam/boozallen_site/dig/pdf/white_paper/the-emergence-of-mlops.pdf).

<sup>10</sup> Notably, the Office of the Under Secretary of Defense for Research & Engineering (OUSD (R&E)) in 2020 outlined a similar vision for an enterprise-wide, shared digital ecosystem to implement the Department's Digital Engineering Strategy and accelerate broad adoption of model-based system engineering. See Andrew Monje, *Future Direction of Model-Based Engineering Across the Department of Defense*, U.S. Department of Defense (Jan. 27, 2020), <https://ac.cto.mil/wp-content/uploads/2020/05/RAMS-Monje-27Jan2020-Future.pdf>.

<sup>11</sup> A common software delivery platform used by industry and academia based on the features of Git (<https://git-scm.com>), GitHub (<https://github.com>), and GitLab (<https://about.gitlab.com>).

<sup>12</sup> Implemented as software as a service (SaaS).

<sup>13</sup> See Chapter 7 of this report. See also Tab 1 - Recommendation 6: "Expedite the development of tools to create tailored AI test beds supported by both virtual and blended environments" in *Second Quarter Recommendations*, NSCAI at 14 (July 2020), <https://www.nscai.gov/previous-reports/>.

<sup>14</sup> See Tab 1 - Recommendation 1: "Create an AI software repository to support AI R&D" in *Second Quarter Recommendations*, NSCAI at 3 (July 2020), <https://www.nscai.gov/previous-reports/>; see also Tab 1 - Recommendation 2: "Promote ATO reciprocity as the default practice within and among programs, Services, and other DoD agencies to enable sharing of software platforms, components, infrastructure, and data for rapid deployment of new capabilities" in *Second Quarter Recommendations*, NSCAI at 5 (July 2020), <https://www.nscai.gov/previous-reports/>.

<sup>15</sup> Implemented as data as a service (DaaS). See Tab 1 - Recommendation 3: "Create a DoD-wide AI data catalog to enable data discovery for AI R&D" in *Second Quarter Recommendations*, NSCAI at 7 (July 2020), <https://www.nscai.gov/previous-reports/>.

<sup>16</sup> The data services and resources provided by the digital ecosystem should support the DoD Data Strategy. See *Executive Summary: DoD Data Strategy*, U.S. Department of Defense (Sept. 30, 2020), <https://media.defense.gov/2020/Oct/08/2002514180/-1/-1/0/DOD-DATA-STRATEGY.PDF>.

<sup>17</sup> For more information on AI documentation, see Chapter 7 of this report and the Appendix containing the abridged version of NSCAI's Key Considerations for Responsible Development & Fielding of AI. See also the Commission's recommendation to produce documentation of the AI life cycle in the section on "Engineering Practices" in *Key Considerations for Responsible Development & Fielding of Artificial Intelligence: Extended Version*, NSCAI (2021) (on file with the Commission).

<sup>18</sup> As part of the funding plan, the Department should consider proposing expansion of the pilot for consumption-based solutions outlined in Section 834 of the FY2021 NDAA to extend across the stack of managed services that compose the digital ecosystem. See Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021).

<sup>19</sup> The DoD CIO should determine the appropriate structure for such a working group, and may decide to leverage or federate existing cross-functional working groups such as those for the DoD Enterprise DevSecOps Initiative or Enterprise Infrastructure. Similarly, DoD CIO should work with pathfinder organizations to determine whether they should be incorporated as part of the governance working group or broken out as a separate community from which to draw best practices.

<sup>20</sup> For example, contributions to the digital ecosystem would come from AI delivery teams at the combatant command headquarters level, and from forward-deployed teams, as they leverage the ecosystem for agile development of AI-driven capabilities.

<sup>21</sup> The list included is intended as a general outline of key stakeholders; it is not exhaustive.

<sup>22</sup> In recent years, the Department has made promising initial steps to establish managed services constructs for platforms, cloud infrastructure, and software development; for example, the Air Force's CloudOne and Platform One as well as multiple in-house software factories such as Kessel Run and Space CAMP (<https://software.af.mil/software-factories> and <https://software.af.mil/dsop/services/>); the Navy's Black Pearl (<https://blackpearl.us/>); and the Army's Coding Repository and Transformation Environment (CReATE); and the new Software Factory at Army Futures Command. Further, the Office of the Secretary of Defense has built a data management platform, ADVANA, with the goal to establish it as the single authoritative source for audit and business data analytics. See Written Statement for the Record of David L. Norquist, Deputy Secretary of Defense before the U.S. Senate Armed Services Committee Subcommittee on Readiness at 6 (Nov. 20, 2019), [https://www.armed-services.senate.gov/imo/media/doc/Norquist\\_11-20-19.pdf](https://www.armed-services.senate.gov/imo/media/doc/Norquist_11-20-19.pdf).

<sup>23</sup> The digital ecosystem's open architecture should be developed with consideration of existing warfighting architectures; for example, the Joint Warfighting Network Architecture recommended in Chapter 3 of this report.

<sup>24</sup> The open architecture should: 1) Define a common set of well-documented common interfaces for the ecosystem's key components and building blocks; 2) Support and integrate the work of existing pathfinders up and down the ecosystem technology stack; and 3) Incorporate the process elements of the DoD DevSecOps Reference Design Version 1.0 Aug. 12, 2019, data authorizations, and continuous software ATO reciprocity.

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<sup>25</sup> The CIO should include guidance along with the open architecture describing what categories of systems are to be adherent and which may be exempt.

<sup>26</sup> Later in this blueprint, NSCAI recommends that USD (R&E) be appointed co-chair and chief science advisor to the Joint Requirements Oversight Council (JROC) for joint and cross-domain capabilities. This recommendation is also emphasized in Chapter 3 of this report.

<sup>27</sup> The Executive Summary that accompanies the DoD Data Strategy states that each Component will develop “measurable Data Strategy Implementation Plans, overseen by the CDO and DoD Data Council.” See *Executive Summary: DoD Data Strategy*, U.S. Department of Defense (Sept. 30, 2020), <https://media.defense.gov/2020/Oct/08/2002514180/-1/-1/0/DOD-DATA-STRATEGY.PDF>.

<sup>28</sup> For example, ensuring contract Data Item Descriptions include the use of application programming interfaces as the data transfer medium. For additional details on AI documentation, see Chapter 7 of this report and the Appendix containing the abridged version of NSCAI’s Key Considerations for Responsible Development & Fielding of AI. See also the Commission’s recommendation to produce documentation of the AI life cycle in the section on “Engineering Practices” in *Key Considerations for Responsible Development & Fielding of Artificial Intelligence: Extended Version*, NSCAI (2021) (on file with the Commission).

<sup>29</sup> Memorandum from Deputy Secretary of Defense, *Actions to Enhance and Accelerate Enterprise Data Management*, U.S. Department of Defense at 1 (Dec. 10, 2020).

<sup>30</sup> As an example, the Steering Committee on Emerging Technology could consider designating the Defense Logistics Agency (DLA) as an enterprise service provider for logistics applications and associated services. These applications would be made available within the ecosystem for reuse and integration. Similarly, upon publication of the reference design, the Committee could explore working with the Intelligence Community to designate and integrate Intelligence Community application service providers (e.g., the National Geospatial Agency for GEOINT application services).

<sup>31</sup> The repository would support implementation of the DoD Data Strategy; the Strategy’s guiding principles include “data is a strategic asset” and “enterprise-wide data access and availability.” See *DoD Data Strategy*, U.S. Department of Defense at 3-4 (Sept. 30, 2020), <https://media.defense.gov/2020/Oct/08/2002514180/-1/-1/0/DOD-DATA-STRATEGY.PDF>.

<sup>32</sup> See “*Advana*” *Defense Analytics Platform – Department of Defense*, ACT-IAC (June 16, 2020), <https://www.youtube.com/watch?v=BIQ31B9Hv44>.

<sup>33</sup> The digital ecosystem rides on the capacity of DoD’s underlying network and communication backbone to provide rapid, on-demand access to the essential AI building blocks. The DoD Digital Modernization Strategy calls out the need to modernize the Department’s primary networks, the warfighter’s communication connectivity, and coalition networks—highlighting the need to upgrade the optical network transport, routers, switches, and satellite gateways. See *DoD Digital Modernization Strategy*, U.S. Department of Defense at 20-21, 35, 37 (July 12, 2019), <https://media.defense.gov/2019/Jul/12/2002156622/-1/-1/1/DOD-DIGITAL-MODERNIZATION-STRATEGY-2019.PDF>.

<sup>34</sup> Components of which are already underway as a result of the JAIC’s Joint Common Foundation initiative.

<sup>35</sup> A common software delivery platform used by industry and academia based on the features of Git (<https://git-scm.com>), GitHub (<https://github.com>), and GitLab (<https://about.gitlab.com>).

<sup>36</sup> See Tab 1 - Recommendation 1: “Create an AI software repository to support AI R&D” in *Second Quarter Recommendations*, NSCAI at 3 (July 2020), <https://www.nscai.gov/previous-reports/>.

<sup>37</sup> See Chapter 7 of this report. See also Tab 1 - Recommendation 6: “Expedite the development of tools to create tailored AI test beds supported by both virtual and blended environments” in *Second Quarter Recommendations*, NSCAI at 14 (July 2020), <https://www.nscai.gov/previous-reports/>.

<sup>38</sup> A federated repository system uses a federated directory that ties distributed repositories together as a virtual whole. See Tab 1 - Recommendation 3: “Create a DoD-wide AI data catalog to enable data discoverability for AI R&D” in *Second Quarter Recommendations*, NSCAI at 7 (July 2020), <https://www.nscai.gov/previous-reports/>.

<sup>39</sup> This would be supported by the prototype centralized data repository recommended above, and hinges on implementation of the new DoD Data Strategy, which details the goals to make DoD data visible, accessible, understandable, linked, trustworthy, interoperable, and secure. *DoD Data Strategy*, U.S. Department of Defense at 6 (Sept. 30, 2020), <https://media.defense.gov/2020/Oct/08/2002514180/-1/-1/0/DOD-DATA-STRATEGY.PDF>.

<sup>40</sup> Trained AI models are a special class of data, and the same federated repository system solution used for DataEx can also be used to support ModelEx.

<sup>41</sup> Another type of anticipated trained AI model is digital twins, as modeling and simulation platforms, such as the Army's One World Terrain advance to support training digital twins through reinforcement learning. For more on *One World Terrain*, see *One World Terrain: A Pillar of the Army's Synthetic Training Environment*, USCICT (Aug. 2, 2019), <https://www.youtube.com/watch?v=K50eL1wU4ic>.

<sup>42</sup> DoD users could choose services off a multi-cloud provider schedule paying as they go for computing resources and uploading/storing the government's data. To facilitate seamless migration of data and software from one platform to another, the DoD should negotiate contracts with providers that appropriately limit expenses related to data egress and migration.

<sup>43</sup> Internally developed software solutions and data sets could be contributed for use across the DoD with built-in incentives for contributors through awarded cloud credits when products are contributed and used. Limited public-facing elements could be brokered on the National AI Research Resource recommended in Chapter 11 of this report.

<sup>44</sup> See Chapter 7 of this report.

<sup>45</sup> These platform environments should have ATO reciprocity for the building blocks they provision, including incorporating DevSecOps development stacks.

<sup>46</sup> Digital ecosystem contributors and users include embedded development teams working at the tactical edge (see below Recommendation: Embed AI development capabilities in support of operations); private sector partners contributing trained models; academic researchers working on open challenge problems; researchers working within a DoD lab; or international partners co-developing interoperable AI capabilities.

<sup>47</sup> Becky Frankiewicz & Tomas Chamorro-Premuzic, *Digital Transformation Is About Talent, Not Technology*, Harvard Business Review (May 6, 2020), <https://hbr.org/2020/05/digital-transformation-is-about-talent-not-technology>.

<sup>48</sup> As recommended in Chapter 7 of this report, national security departments and agencies should provide ongoing training to help the workforce better interact, collaborate with, and be supported by AI systems—including understanding AI tools.

<sup>49</sup> Steve Blank & Pete Newell, *What Your Innovation Process Should Look Like*, Harvard Business Review (Sept. 11, 2017), <https://hbr.org/2017/09/what-your-innovation-process-should-look-like>.

<sup>50</sup> Andrew Moore, et al., *The AI Stack: A Blueprint for Developing and Deploying Artificial Intelligence*, Proc. SPIE 10635 (May 4, 2018), <https://doi.org/10.1117/12.2309483>. For a graphical depiction of the AI stack, see *About*, Carnegie Mellon University Artificial Intelligence (last accessed Jan. 1, 2021), <https://ai.cs.cmu.edu/about>.

<sup>51</sup> Pub. L. 109-364, John Warner National Defense Authorization Act for Fiscal Year 2007, 109th Congress (2006).

<sup>52</sup> *DoD Instruction 1300.19: DOD Joint Officer Management Program*, U.S. Department of Defense at 14 (April 3, 2018), <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/130019p.pdf?ver=2018-04-03-114842-923>.

<sup>53</sup> See Chapter 2 of this report and this associated Blueprint for Action section below about leveraging public-private talent exchanges to infuse technical expertise into the acquisition corps for NSCAI's recommendation to create a technology fellows program to support development of a Technology Annex to the National Defense Strategy; there are numerous extant fellowships across the DoD involving emerging technologies.

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<sup>54</sup> This action aligns with the recommendation to establish a strategic data node within the digital ecosystem discussed earlier in this Blueprint and with the DoD Data Strategy, which lists Senior Leader Decision Support and Business Analytics as initial areas of focus. See *DoD Data Strategy*, U.S. Department of Defense at 11 (Sept. 30, 2020), <https://media.defense.gov/2020/Oct/08/2002514180/-1/-1/0/DOD-DATA-STRATEGY.PDF>.

<sup>55</sup> Notably, this recommendation is aligned with Section 836 of the FY 2021 National Defense Authorization Act, which directs the Secretary of Defense to develop and integrate advanced digital data management and analytics capabilities that integrate all aspects of the defense acquisition system; facilitate the management and analysis of all relevant data; enable the use of such data to inform further development, acquisition, management, and oversight of such systems, including portfolio management; and include software capabilities to collect, transport, organize, manage, make available, and analyze relevant data throughout the life cycle of defense acquisition programs. The section further requires capability demonstrations and revised policies to promote the use of digital management and analytics capabilities by March 15, 2022. Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021).

<sup>56</sup> For example, critical human resource variables such as performance and retention are likely related to budget variables (pay), health care variables (accessibility and quality of care) and even real estate variables (housing). These relationships will become transparent and quantifiable when data tagging supports cross domain analyses.

<sup>57</sup> Gamechanger is an AI-enabled tool designed to analyze documentation of U.S. government legislation, policies, and regulations for semantic content, to trace authorities and responsibilities across documents, and to map authorities and responsibilities to agencies and officials designated therein.

<sup>58</sup> See discussion below for details on the responsibilities envisioned for JAIC as the Department's AI Accelerator.

<sup>59</sup> For example, DIU is currently pursuing a number of AI projects to optimize business processes in the DoD—ranging from using AI-driven Robotic Process Automation to reduce labor costs for the Army Comptroller, to improving Air Force readiness with AI-driven predictive maintenance, to leveraging AI-constructed knowledge graphs to rapidly identify supply chain risks. See *JAIC Partners with DIU on AI/ML Models to Resolve Complex Financial Errors*, JAIC (Oct. 1, 2020), [https://www.ai.mil/blog/10\\_01\\_20-jaic-partners-with-diu-on-ai/ml-models-to-resolve-complex-financial-errors.html](https://www.ai.mil/blog/10_01_20-jaic-partners-with-diu-on-ai/ml-models-to-resolve-complex-financial-errors.html); *U.S. Defense Department Awards C3.ai \$95M Contract Vehicle to Improve Aircraft Readiness Using AI*, Business Wire (Jan. 15, 2020), <https://www.businesswire.com/news/home/20200115005413/en/US-Defense-Department-Awards-C3.ai-95M-Contract-Vehicle-to-Improve-Aircraft-Readiness-Using-AI>; *Accrete.AI Accelerates Growth and Product Adoption with Defense Innovation Unit Contract*, Accrete.ai (April 23, 2020), <https://blog.accrete.ai/newsroom/accrete.ai-wins-million-dollar-contract-with-the-defense-innovation-unit>.

<sup>60</sup> This should include an evaluation of existing policies and regulations on contract data rights, data format, data definitions, and data environments to accelerate application of commercial AI for acquisition, management, and oversight and maximize insights derived.

<sup>61</sup> For a glimpse into the DoD's innovation ecosystem, see *Tap the Innovation Ecosystem*, MITRE: Acquisition in the Digital Age, (last accessed Jan. 25, 2020), <https://aida.mitre.org/demystifying-dod/innovation-ecosystem/>; *Understanding the DoD Innovation Ecosystem*, MITRE: Bridging Innovation (last accessed Jan. 25, 2020), <https://bridge.mitre.org/visualization/>.

<sup>62</sup> See *Interim Report*, NSCAI at 31 (November 2019), <https://www.nscai.gov/previous-reports/>.

<sup>63</sup> The term "digital innovation initiatives" is used here to describe the various entities across the Office of the Secretary of Defense and the military services, such as the Defense Innovation Unit (DIU), AFWERX, NavalX, and Army Applications Laboratory (AAL), that are focused on bridging the gap with the commercial technology section—especially startups and non-traditional vendors—and accelerating the delivery of best-of-breed technology solutions.

<sup>64</sup> As the Department's Chief Technology Officer, USD (R&E) has both the authority and mandate to coordinate discrete efforts across OSD and the military services to accelerate the adoption of digital technology and expand the national security innovation base (NSIB). However, USD (R&E) must ensure close coordination with USD (A&S) and, in the case of IT and information systems, DoD CIO, to improve the transition of solutions emerging from these organizations into operational systems.

<sup>65</sup> For example, through current SBIR “bridging” funds described in Chapter 11 of this report or technology-specific supplemental funding recommended later in this Blueprint for Action under, “Make supplemental funding available to drive operational prototyping, scale, and transition of AI technologies.”

<sup>66</sup> As the Chief Technology Officer of the DoD, USD (R&E) has a “mission to advance technology and innovation.” Additionally, USD (R&E) is responsible for advis[ing] the Secretary of Defense on all matters related to research; engineering; manufacturing; developmental test & evaluation; and technology development, innovation, and protection activities and programs in the DoD and occurring internationally [as well as] establishing priorities across those matters to ensure conformance with Secretary of Defense policy and guidance. For a full list of USD (R&E)’s responsibilities and functions, see *DoDD Directive 5137.02: Under Secretary Of Defense For Research And Engineering (USD (R&E))*, U.S. Department of Defense (Jan. 4, 2021), <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/513702p.pdf?ver=2020-07-15-124712-047>. [hereinafter DoDD 5137.02]

<sup>67</sup> For example, DIU leverages Other Transaction Authority (OTA) and the Commercial Solutions Opening process to “test, field, and scale commercial technology in less than 24 months.” The Air Force’s AFWERX, in partnership with Air Force Research Lab (AFRL) and DIU’s National Security Innovation Network (NSIN), has pioneered new approaches to Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) funding to “increase the efficiency, effectiveness, and transition rate” of the program. See *Annual Report 2019*, Defense Innovation Unit at 4 (2019), [https://assets.ctfassets.net/3nanhbtkr0pc/ZF9fhsMe6jtX15APMLall/cd088a59b91857c5146676e879a615bd/DIU\\_2019\\_Annual\\_Report.pdf](https://assets.ctfassets.net/3nanhbtkr0pc/ZF9fhsMe6jtX15APMLall/cd088a59b91857c5146676e879a615bd/DIU_2019_Annual_Report.pdf); *SBIR Open Topics*, U.S. Air Force AFWERX (last accessed Jan. 1, 2021), <https://www.afwerx.af.mil/sbir.html>.

<sup>68</sup> Also informed by the JAIC, and made accessible through the digital ecosystem.

<sup>69</sup> As described in Chapter 3 of this report, there should be a push-pull relationship between innovative technologies and concepts such that the Technology Annex informs, but does not limit, the scope of activity. Digital Innovation Initiatives will likely continue to have responsibilities outside of this go-to-market strategy; for example, the acceleration of commercial AI applications for core business processes.

<sup>70</sup> The impact and potential use cases of investments may not be apparent for several years. This review aims to provide insight into current activities so as to influence, but not dictate, modifications to the next “go-to-market strategy.” This process should be automated to the maximum extent possible to minimize overhead.

<sup>71</sup> Many of the processes and technical roadblocks faced by traditional and non-traditional vendors that slow critical efforts to build and integrate AI systems will be greatly diminished by the implementation of a digital ecosystem, as described above. However, until then, top-down support at the highest levels of leadership will be essential to empower digital innovation initiatives. Per DoDD 5137.02, part of USD (R&E)’s functions include working in conjunction with the USD (A&S) to identify, evaluate, and promote opportunities to reduce barriers to entry for commercial technologies and non-traditional defense partners; and leading initiatives to engage non-traditional suppliers of technology. See DoDD 5137.02.

<sup>72</sup> Where appropriate, efforts should leverage expertise from FFRDCs and UARCs.

<sup>73</sup> Prototyping contracts provide non-recurring engineering dollars to companies for early-stage technologies and projects “to evaluate and inform [their] feasibility or usefulness.” Often, these dollars come from dedicated funds, such as the SBIR and STTR programs and DIU’s internal prototyping budget; and are distributed by organizations like DIU outside of the acquisition life cycle domains, including DoD programs of record (PoR). Companies executing promising projects through these mechanisms often exhaust prototype funding and are unable to secure sustainable follow-on contracts (i.e., with a clear path toward integration into a PoR) because they cannot identify a customer, or the customer’s funding is already committed. AFWERX improved transition in its SBIR program by achieving buy-in from potential customers through matching program funds. See Tab 1 - Recommendation 7: “Strengthen Return on SBIR Investments” in *Interim Report and Third Quarter Recommendations*, NSCAI at 52 (October 2020), <https://www.nscai.gov/previous-reports/>; Prototyping Guidebook, U.S. Department of Defense at 36 (November 2019), <https://www.dau.edu/tools/Lists/DAUTools/Attachments/329/DoD%20Prototyping%20Guidebook.%20v2.0.pdf>.

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<sup>74</sup> For example, at least one F-22 and F-35 aircraft designated as AI test beds could incentivize existing contractors and non-traditional firms to work together and better align their incentives to field new mission capabilities. Such an initiative would build on initial efforts to integrate agile software development into F-22 modernization programs. See Craig Ulsh, *Software Acquisition and Practices (SWAP) Study: Vignettes*, DoD Defense Innovation Board at 6 (Jan. 10, 2019), [https://media.defense.gov/2019/Mar/07/2002097482/-1/-1/0/SWAP\\_STUDY\\_VIGNETTES.PDF](https://media.defense.gov/2019/Mar/07/2002097482/-1/-1/0/SWAP_STUDY_VIGNETTES.PDF).

<sup>75</sup> The 2019 National Defense Authorization Act identified metrics for DIU to report, such as: the number and types of transitions by the Unit to the military departments or fielded to the warfighter; and the impact of the Unit's initiatives, outreach, and investments on Department of Defense access to technology leaders and technology not otherwise accessible to the Department, including the number of non-traditional defense contractors with Department of Defense contracts or other transactions resulting directly from the Unit's initiatives, investments, or outreach; the number of traditional defense contractors with contracts or other transactions resulting directly from the Unit's initiatives; and the number of innovations delivered into the hands of the warfighter. See Pub. L. 115-232, sec. 244, John S. McCain National Defense Authorization Act for Fiscal Year 2019, 115th Congress (2018); Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021).

<sup>76</sup> This metric should be appropriately scoped such that consideration is given to products or solutions that lend themselves to enterprise licensing agreements and prioritize measures that indicate the level of cross-service, cross-unit proliferation of a solution.

<sup>77</sup> A 2019 study conducted by the Defense Innovation Board Defense reached similar conclusions with regard to software acquisitions generally, stating that the current approach to software development is broken and is a leading source of risk to DoD; it takes too long, is too expensive, and exposes warfighters to unacceptable risk by delaying their access to tools they need to ensure mission success. *Software is Never Done: Refactoring the Acquisition Code for Competitive Advantage*, DoD Defense Innovation Board at i (May 2019), <https://media.defense.gov/2019/May/01/2002126689/-1/-1/0/SWAP%20COMPLETE%20REPORT.PDF>.

<sup>78</sup> The Adaptive Acquisition Framework promotes use of tailored acquisition approaches based on the needed capability. It includes six guiding pathways for acquiring capabilities that Milestone Decision Authorities (MDAs), other Decision Authorities (DAs), and Program Managers (PMs) can "tailor, combine, and transition between": Urgent Capability Acquisition, Middle Tier of Acquisition, Major Capability Acquisition, Software Acquisition, Defense Business Systems, and Acquisition of Services. See *Adaptive Acquisition Framework Pathways*, Defense Acquisition University, (last accessed Dec. 26, 2020), <https://aaf.dau.edu/aaf/aaf-pathways/>. The Software Acquisition Pathway was developed based on a recommendation from the Defense Innovation Board in the 2019 Software Study. See *Software is Never Done: Refactoring the Acquisition Code for Competitive Advantage*, DoD Defense Innovation Board at 37, S2 (May 2019), <https://media.defense.gov/2019/May/01/2002126689/-1/-1/0/SWAP%20COMPLETE%20REPORT.PDF>.

<sup>79</sup> The Contracting Cone outlines all Federal Acquisition Regulation (FAR) and Non-FAR contract strategies. *Contracting Cone*, Defense Acquisition University (last accessed Dec. 20, 2020), <https://aaf.dau.edu/aaf/contracting-cone/>.

<sup>80</sup> Specialized pathways include approaches captured within the Department's Adaptive Acquisition Framework such as the Middle Tier of Acquisition and Software Acquisition that are exempted from certain requirements within the Defense Acquisition System.

<sup>81</sup> In January 2020, former Under Secretary of Defense for Policy Michele Flournoy cited concern over inadequate training and incentives for acquisition professionals to make full use of authorities provided by Congress. She noted "pockets of [acquisition] excellence" in Special Operations Command and the Air Force, but argued the larger acquisition corps "is not using the authorities effectively, consistently, and at scale." See Testimony of The Honorable Michele A. Flournoy, former Under Secretary of Defense for Policy before the U.S. House of Representatives Armed Services Committee, *Hearing on DoD's Role in Competing with China* at 6 (Jan. 15, 2020), [https://armedservices.house.gov/\\_cache/files/4/4/44fbef3d-138c-4a0a-b3a9-2f05c898578f/0E4943A5BFAE DA465D485A166FABCF5F.20200115-hasc-michele-flournoy-statement-vfinal.pdf](https://armedservices.house.gov/_cache/files/4/4/44fbef3d-138c-4a0a-b3a9-2f05c898578f/0E4943A5BFAE DA465D485A166FABCF5F.20200115-hasc-michele-flournoy-statement-vfinal.pdf).

<sup>82</sup> Including Federal Acquisition Regulation (FAR)-based approaches and non-FAR-based approaches as outlined in the Defense Acquisition University's Contracting Cone. See *Contracting Cone*, Defense Acquisition University (last accessed Dec. 20, 2020), <https://aaf.dau.edu/aaf/contracting-cone/>.

<sup>83</sup> Such as the middle tier of acquisition and the software acquisition pathway.

<sup>84</sup> For example, efforts associated with section 230 of the Fiscal Year 2020 NDAA on talent management of digital expertise and software professionals; section 256 on an education strategy for Artificial Intelligence; and section 862 of the FY2020 NDAA on software development and software acquisition training and management programs. In support of the implementation of Section 862, USD (A&S) is developing a pilot software acquisition training program that aims to better enable the “creation and execution of acquisition strategies and contracts that support the speed of technology and change” by providing students with the foundations of digital technologies through evolutionary content in context of the Defense Acquisition System. *Digital DNA: Software Acquisition Training Pilot*, U.S. Department of Defense at 1 (on file with the Commission); see also *Report to Congress on FY20 NDAA Section 862(b)(1)(B) Software Development and Software Acquisition Training and Management Programs*, U.S. Department of Defense at Appendix H (January 2021), [https://www.hci.mil/docs/Policy/FY20\\_NDAASec862ReportToCongress\\_DoDSoftwDevSoftwAcqTngMgt\\_Jan2021.pdf](https://www.hci.mil/docs/Policy/FY20_NDAASec862ReportToCongress_DoDSoftwDevSoftwAcqTngMgt_Jan2021.pdf).

<sup>85</sup> This should be coordinated appropriately with the relevant legal and ethics officials to avoid any potential conflicts of interest.

<sup>86</sup> Section 1102 of the FY2021 National Defense Authorization Act directs the Secretary of Defense to provide briefings to the defense authorization committees on implementation of public-private exchange programs and recommendations for statutory changes to improve their use and effectiveness. Section 1102 also directs the Secretary to take steps to ensure the exchange program is applied to the defense modernization priorities—including AI. While USD (R&E)’s modernization directors are responsible for “unifying and advancing the Department’s investments and capabilities [in their areas], and ensur[ing] the transition of technologies into operational use,” the Department’s acquisition professionals will be the personnel ultimately responsible for operationalizing the modernization priorities. See Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021); see also *Modernization Priorities*, U.S. Department of Defense, USD (R&E), (last accessed Dec. 28, 2020), <https://www.cto.mil/modernization-priorities/>.

<sup>87</sup> The DoD has already begun to make progress in these areas. For example, the Advanced Distributed Learning (ADL) Initiative under the Office of the Under Secretary of Defense for Personnel and Readiness (USD (P&R)), which originated in the 1990s, is a DoD-wide program for modernizing DoD training/education, including the use of learning technologies and platforms, and support for content sharing, collaboration, and interoperability. ADL is currently pursuing an Enterprise Course Catalog to federate disparate or decentralized catalogs across the organization, aggregating the content into a single, Defense-wide portal. See *Enterprise Course Catalog (ECC)*, Advanced Distributed Learning Initiative (last accessed Feb. 12, 2021), <https://adlnet.gov/projects/ecc/>.

<sup>88</sup> Including DoD-specific training as well as relevant commercial and open-source training.

<sup>89</sup> Examples could include draft acquisition strategy documents for programs planning to use the middle tier or software acquisition pathways; model contracting language for AI technologies, etc.

<sup>90</sup> Including on new or innovative acquisition approaches and best practices as well as new or emerging digital technologies and technical approaches (e.g., digital engineering, MLOps, etc.).

<sup>91</sup> This recommendation echoes a recommendation made by the Defense Innovation Board (DIB) in a 2019 study on software acquisition and practices within the Department of Defense. The DIB called for a new acquisition pathway for software that would prioritize continuous integration and delivery of working software in a secure manner, with continuous oversight from automated analytics. The DIB provided draft legislative language in the body of the report for consideration by the DoD and Armed Services Committees in implementing this recommendation. The draft legislative text indicated the need for a rapid contracting mechanism to be established as part of the software pathway. Although the creation of a software acquisition pathway was directed by section 800 of the FY2020 NDAA and the Department has since issued a formal policy on the pathway, the rapid contracting mechanism remains unimplemented. See *Software is Never Done: Refactoring the Acquisition Code for Competitive Advantage*, DoD Defense Innovation Board at S58 (May 2019), <https://media.defense.gov/2019/May/01/2002126689/-1/-1/0/SWAP%20COMPLETE%20REPORT.PDF>; Pub. L. 116-92, National Defense Authorization Act for Fiscal Year 2020; *DoD Instruction 5000.87: Operation of the Software Acquisition Pathway*, U.S. Department of Defense (Oct. 2, 2020), [https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500087p.PDF?ver=virAfQj4v\\_LgN1JxpB\\_dpA%3D%3D](https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500087p.PDF?ver=virAfQj4v_LgN1JxpB_dpA%3D%3D).

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<sup>92</sup> Using system-level program elements incentivizes programs to build “full stack” with each subcomponent and enabling technology being built and procured individually as part of the broader program makeup. This reduces risk. In recent years, enabling services such as Platform One have re-emerged, but it is difficult to justify base operating budgets for these organizations because they are not tied to discrete outputs. See Eric Lofgren, *The DoD Budget Process: the Next Frontier of Acquisition Reform*, George Mason University Center for Government Contracting (July 9, 2020), [https://business.gmu.edu/images/GovCon/White\\_Papers/The\\_DoD\\_Budget\\_Process.pdf](https://business.gmu.edu/images/GovCon/White_Papers/The_DoD_Budget_Process.pdf).

<sup>93</sup> Joint Capabilities Integration and Development System (JCIDS) and the Planning, Programming, Budget and Execution (PPBE) process are tightly linked. Military needs drive the development of new programs to deliver capability. Traditionally derived from concepts of operations, these needs are the basis against which the Department evaluates, costs, and ultimately pursues a solution. If the Department determines that a material solution is necessary, the need will be decomposed into requirements that prescribe the design, specification, and function of the system intended to deliver the capability. Once validated, these requirements drive the DoD’s budget. *Id.* at 5.

<sup>94</sup> Commonly known as “colors of money,” DoD funds are appropriated into the following categories, each with its own allowable uses per law: Research, Development, Test & Evaluation (RDT&E) dollars, Procurement dollars, Operations & Maintenance (O&M), and Sustainment dollars.

<sup>95</sup> The distinction between research and development funds and operating funds disincentivizes the cycle of continuous development and integration necessary to derive value from AI and software-based applications. Within the RDT&E appropriation alone, separate funding for research, development, prototyping, and fielding assumes a slow linear progression from lab to field pre-defined system requirements that allow for little to no user feedback. Once fielded, appropriations law governing the use of O&M funds challenges upgrades to digital systems.

<sup>96</sup> Congressional testimony from former Under Secretary of Defense for Policy Michele Flournoy highlights the centrality of experimentation to developing new concepts and capabilities at the speed required to outpace our competitors. See Testimony of The Honorable Michele A. Flournoy, former Under Secretary of Defense for Policy before the U.S. House of Representatives Armed Services Committee, *Hearing on DoD’s Role in Competing with China* at 8 (Jan. 15, 2020), [https://armedservices.house.gov/\\_cache/files/4/4/44fbef3d-138c-4a0a-b3a9-2f05c898578f/0E4943A5BFAE DA465D485A166FABCF5F.20200115-hasc-michele-flournoy-statement-vfinal.pdf](https://armedservices.house.gov/_cache/files/4/4/44fbef3d-138c-4a0a-b3a9-2f05c898578f/0E4943A5BFAE DA465D485A166FABCF5F.20200115-hasc-michele-flournoy-statement-vfinal.pdf).

<sup>97</sup> Requirements are developed that drive technological development, and prototyping and experimentation occur as a means to refine requirements and manage risk. This incentivizes integration of incremental technologies into programs of record rather than disruptive or rapidly changing user-centered technologies, such as AI; and limits the ability of program managers to respond to any fast-paced change in technology later in the life of the program. See Pete Modigliani et al., *Modernizing DoD Requirements: Enabling Speed, Agility, and Innovation*, The MITRE Center for Technology and National Security (March 2020), <https://www.mitre.org/sites/default/files/publications/pr-19-03715-2-modernizing-dod-requirements-enabling-speed-agility-and-innovation.pdf>.

<sup>98</sup> The budget activity 8 (BA 8) pilot seeks to overcome the barrier that DoD spending categories pose to the development and sustainment of digital technologies. The Office of the Under Secretary of Defense for Acquisition and Sustainment and the Office of the Under Secretary of Defense for Comptroller selected nine programs to begin to pilot the BA 8 for FY2021. Defense appropriators approved eight of the nine programs, and BA 8 is being established for each Service and Defense-wide under the Research, Development, Test & Evaluation appropriation and enable two-year funding. See H.R. 133, Consolidated Appropriations Act, 2021, 116th Congress (2020), <https://docs.house.gov/billsthisweek/20201221/BILLS-116RCP68-JES-DIVISION-C.pdf?source=email> (joint explanatory statement at 118).

<sup>99</sup> Appointing USD (R&E) Co-Chair and Chief Science Advisor to the JROC would help push forward efforts to reform requirements generation and validation. Serving as the system architect for joint and cross-domain solutions, USD (R&E) would advocate for more flexible system design and specifications such as modular open systems architecture and standards, well-documented application programming interfaces (APIs). See Chapter 3 of this report. See also Tab 2 - Recommendation 2: “USD (R&E) should be appointed the Co-Chair and Chief Science Advisor to the Joint Requirements Oversight Council (JROC) for Joint and cross-domain capabilities” in *Interim Report and Third Quarter Recommendations*, NSCAI at 70 (October 2020), <https://www.nscai.gov/previous-reports/>.

<sup>100</sup> Section 809 of the FY2021 NDAA directs the Secretary of Defense and the Director for Extramural Innovation and Research Activities to “conduct an assessment of the processes for developing and approving capability requirements for the acquisition programs of the Department of Defense and each military department” and submit reports to the defense authorization committees. Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021). Section 809 further stipulates that, as part of the assessment, both officials must evaluate the “extent to which portfolio management techniques are used in the process for development capability requirements to coordinate decisions and avoid duplication of capabilities across acquisition programs.” *Id.* The Joint Explanatory Statement accompanying the provision indicates that the Department shall consider the recommendations made in the MITRE Corporation’s *Modernizing the Requirements Process: Enabling Speed, Agility, and Innovation* as part of the directed assessment. Recommendations include the establishment of enterprise-level requirements or “Warfighter Essential Requirements” for capabilities to ensure acquisition programs are closely aligned to warfighter needs, drive systems of systems approaches and reduce redundancies between and among services and domains; and enable budget and requirements trade-offs through a portfolio management approach. The authors also recommend different management approaches for requirements based on the attributes of the system being developed. See Pete Modigliani, et al., *Modernizing the Requirements Process: Enabling Speed, Agility, and Innovation*, MITRE (March 2020), <https://www.mitre.org/sites/default/files/publications/pr-19-03715-2-modernizing-dod-requirements-enabling-speed-agility-and-innovation.pdf>.

<sup>101</sup> A formal legislative proposal may not be required. DoD retains discretion in the structure and objectives of annual budget proposals. However, approval from Congress and the Office of Management and Budget is required.

<sup>102</sup> Such as dashboards and digital engineering artifacts.

<sup>103</sup> USD (R&E) should work closely with the JAIC, the Joint Staff, and the military services to identify specific programs and mission areas ripe for potential application of AI technologies, with particular attention to near-term warfighter needs from the Combatant Commands, and use the fund to accelerate efforts in those areas. Establishment of this fund would need to be accompanied with transfer authority such that USD (R&E) could transfer resources to the relevant entities to conduct these activities.

<sup>104</sup> This is being led by the DoD Office of the Under Secretary of Defense for Comptroller and Office of the Under Secretary of Defense for Acquisition and Sustainment, based on the findings and recommendations of the Defense Innovation Board’s Software Acquisition and Practices Study. *Software is Never Done: Refactoring the Acquisition Code for Competitive Advantage*, DoD Defense Innovation Board (May 2019), [https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/ SOFTWAREISNEVERDONE\\_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE\\_FINAL\\_SWAP.REPORT.PDF](https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/SOFTWAREISNEVERDONE_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE_FINAL_SWAP.REPORT.PDF). Jeff Boleng, Special Assistant for Software Acquisition to the Under Secretary of Defense for Acquisition and Sustainment, publicly stated the goal of the pilot as “simplifying the budget process, increasing the visibility, accountability of the funding.” Billy Mitchell, *DOD has OMB Support for Special Software-only Appropriations Pilots*, FedScoop (Sept. 10, 2019), <https://www.fedscoop.com/dod-omb-support-special-software-appropriations-pilots/>. In public remarks made March 3, 2020, Under Secretary of Defense for Acquisition and Sustainment Ellen Lord underscored the significance of the pilot, asserting, “we will begin to see results almost instantaneously, because the administrative burden of making sure you are charging the right development number, the right production number, the right sustainment number, slows things down.” Jared Serbu, *Pentagon Teeing Up Nine Programs to Test New ‘Color of Money’ for Software Development*, Federal News Network (March 4, 2020), <https://federalnewsnetwork.com/acquisition/2020/03/pentagon-teeing-up-nine-programs-to-test-new-color-of-money-for-software-development/>; *West 2020: 3 March 2020 Morning Keynote with The Honorable Ellen Lord*, WEST Conference (March 3, 2020), <https://www.youtube.com/watch?v=VGlqjyMhtok&list=PLFZb4znlHwx0TcsirmyYD6k5BAYxDRwU0&index=6&t=0s>.

<sup>105</sup> For example: budget activities within the appropriation could be aligned to a DoD Component; program elements or budget lines under the budget activities would align to joint capabilities (e.g., Joint Command and Control) and then further decomposed into projects (i.e., key systems, investments, and supporting activities).

<sup>106</sup> Often, technology that has been in use in the commercial sector for years.

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<sup>107</sup> Section 232 of the National Defense Authorization Act for FY2021 designates the JAIC as a direct report to the Deputy Secretary of Defense, adds to the JAIC's responsibilities the "acquisition and development of mature artificial intelligence technologies in support of defense missions," and directs the Secretary of Defense to clarify the roles and responsibilities of various DoD Components relative to the "research, development, prototyping, testing, procurement of, requirements for, and operational use of artificial intelligence technologies." See Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021).

<sup>108</sup> Best practices could include user-centered approaches such as problem discovery, which could be captured and shared via a modern, queryable knowledge management system; or algorithms or models added to the JAIC's repository within the digital ecosystem.

<sup>109</sup> For example, identity-based user authentication and access controls; definition of common standard interfaces and documentation requirements; and accreditation and ATO reciprocity. See full list above.

<sup>110</sup> For example, working with the Office of the Under Secretary of Defense, the Defense Contract Management Agency, Service Acquisition Executives, and other relevant parties responsible for acquisition and procurement activities to develop model contract language that incorporates the standards and practices outlined in NSCAI's *Key Considerations for Responsible Development & Fielding of AI*. These would apply both to systems developed by DoD, as well as those that are acquired (including Commercial off-the-shelf systems or those developed by contractors). See the Appendix of this report containing the abridged version of NSCAI's Key Considerations for Responsible Development & Fielding of AI. For additional details on the Commission's recommendation for governance, see the sections on "Aligning Systems and Uses with American Values and the Rule of Law" and "Accountability and Governance" in *Key Considerations for Responsible Development & Fielding of Artificial Intelligence: Extended Version*, NSCAI (2021) (on file with the Commission).

<sup>111</sup> More details for a TEVV framework can be found in Chapter 7 of this report.

<sup>112</sup> AI applications are extremely diverse and thereby necessitate a wide range of testing methods. Establishing common approaches to tailoring appropriate processes and tools to the type of AI application at hand will support the ability of DoD components to embrace and scale AI solutions by shortening the testing cycle and making test results interpretable and comparable across the Department. Given the diversity of use cases, the framework would not embody a one-size-fits-all approach, but rather provide core capabilities and guidance adaptable across application areas. For a full discussion on this framework, and required resourcing, see Chapter 7 of this report.

<sup>113</sup> Depending on the current state of the implementation of the digital ecosystem, this shared access could be accomplished through the federated system of distributed software repositories—whether the JAIC's software repository or one managed by a DoD component that originally developed or licensed the software tool.

<sup>114</sup> Including tools for TEVV. This effort should also determine what AI development tools are already available across the Department (e.g., where commercial software licenses already exist) and, leveraging the acquisition authority granted in the FY2021 NDAA, procuring leading-edge AI development tools with licensing terms to support enterprise-wide usage. Reasonable consideration should be given for the maturity of the product/tool and likelihood of enterprise use. Section 808 of the FY 2021 National Defense Authorization Act grants the Director of the Joint Artificial Intelligence Center acquisition authority up to \$75 million out of the funds made available in FiY 2021-2015 to enter into new contracts. Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021).

<sup>115</sup> Such as data scientists, AI and software engineers, infrastructure engineers, product managers, and other key positions.

<sup>116</sup> Including full stack development, engineering, testing, integration, etc., for AI applications and systems.

<sup>117</sup> To reduce barriers to entry, the Department could also consider pairing the Blanket Ordering Agreement or Blanket Purchasing Agreement with a Broad Agency Announcement or Commercial Solutions Open solicitation procedure.

<sup>118</sup> This should include a diverse cross-section of expertise that at a minimum includes engineering (i.e., data science and AI solutions), AI digital ecosystem architecture, AI software experts, product managers; and acquisition, legal, policy experts as well as domain experts.

<sup>119</sup> This could also involve JAIC representatives embedded at Combatant Command headquarters where appropriate and feasible.

<sup>120</sup> Of note, the NSCAI Interim Report Appendix 3: Workforce Model's recommendations are designed to support this model, with AI experts and developers serving at hubs, developers serving in spokes, and deployment specialist training helping domain experts maintain data sets and software and better partner with experts and developers. *Interim Report*, NSCAI at 61 (November 2019), <https://www.nscai.gov/previous-reports/>.

<sup>121</sup> CCMDs have specific operational needs that routinely outpace centralized development approaches. Modern battlefield dynamics require that each commander have the ability to tailor the character of his or her war to out-adapt the adversary.

<sup>122</sup> To stand-up these teams quickly, the CCMDs could leverage the enterprise contracting vehicles through the JAIC to access a pre-vetted pool of talent with AI engineering, data science, and product management competencies. If local contracting vehicles are used, contract provisions should require that all development efforts are interoperable with and leverage the digital ecosystem.

<sup>123</sup> In this way, the AI delivery teams will contribute to a growing resource of shared data and software within the digital ecosystem by consuming ecosystem services, developing and fielding tailored AI capabilities, and integrating them into sustainable projects available for use across the department.

<sup>124</sup> As an example, both Army Futures Command (AFC) and Army Special Operations Command (USASOC) use a model known as "tactical data teams." This model brings AI/ML expertise forward to the field in the form of three- to six-person teams to build AI solutions for real-time operational problems. Executed by a small business, Striveworks, under contract with AFC and USASOC, they are currently supporting efforts in Central Command and Indo-Pacific Command Areas of Responsibility.

<sup>125</sup> These are similar interactions with the digital ecosystem as those taken by the delivery teams at Combatant Command HQ, only the forward-deployed development team will be consuming digital ecosystem services locally on their provisioned mobile platform. Collocation of the developers with operators will drive real-time experimentation and shorten application feedback loops.

<sup>126</sup> DoD lacks reliable budget data to track its investments in AI and other critical technologies; a weakness that should be addressed at the source with AI applications that assist humans in generating program descriptions and other budget artifacts.

<sup>127</sup> For a full discussion of how AI will change warfare, see Chapter 3 of this report.

<sup>128</sup> For a list of priority AI R&D research areas, see Chapter 3 of this report.

<sup>129</sup> The Defense Science Board has recommended the level of 3.4% to mirror best practices in the private sector multiple times. *Department of Defense Research, Development, Test, and Evaluation (RDT&E): Appropriations Structure*, Congressional Research Service at 12 (Oct. 7, 2020), <https://fas.org/sgp/crs/natsec/R44711.pdf>.

<sup>130</sup> While defense budgets are projected to flatten or decline in the coming years, the threat environment will only increase in complexity. To meet these new realities, we must create more room in the budget while simultaneously increasing the lethality of our forces. By retiring legacy systems and investing more in emerging technologies and, over the longer term, portfolios of attritable systems, DoD can pursue these needs in tandem, boosting the composability and adaptability of our military forces.

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<sup>131</sup> Former Secretary of Defense Mark Esper pioneered his “night-court” budgeting process as Army Secretary (2017-2019) and later applied it Department-wide. He “took a hard look at legacy department programs and cut a number of them, refocusing funds on efforts to challenge China and Russia.” As Army Secretary, he “helped guide those restructurings through Congress, and the process, which found around \$25 billion in savings, has garnered largely positive reviews.” Aaron Mehta & Joe Gould, *Night Court Comes to the Pentagon*, Defense News (Aug. 28, 2019), <https://www.defensenews.com/pentagon/2019/08/28/night-court-comes-to-the-pentagon/>. According to the Pentagon’s press release detailing the highlights of the FY2021 budget proposal, the process applied defense-wide generated \$5.7 billion in FY2021 savings, \$0.2 billion in Working Capital Fund efficiencies, and another \$2.1 billion in activities and functions realigned to the Services. Press Release, The Office of the Under Secretary of Defense for Comptroller, *DoD Releases FY 2021 Budget Proposal*, [https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/fy2021\\_Press\\_Release.pdf](https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/fy2021_Press_Release.pdf).

<sup>132</sup> This echoes a recommendation made by the Future of Defense Task Force. The Task Force recommended that Congress commission the RAND Corporation (or similar entity) and the Government Accountability Office to study legacy platforms within the Department of Defense and determine their relevance and resiliency to emerging threats over the next 50 years. The Task Force further recommended that upon completion of the studies, “a panel should be convened, comprising Congress, DoD, and representatives from the industrial base to make recommendations on which platforms should be retired, replaced, or recapitalized.” *Future of Defense Task Force Report 2020*, House Armed Services Committee at 8 (Sept. 23, 2020), [https://armedservices.house.gov/\\_cache/files/2/6/26129500-d208-47ba-a9f7-25a8f82828b0/424EB2008281A3C79BA8C7EA71890AE9.future-of-defense-task-force-report.pdf](https://armedservices.house.gov/_cache/files/2/6/26129500-d208-47ba-a9f7-25a8f82828b0/424EB2008281A3C79BA8C7EA71890AE9.future-of-defense-task-force-report.pdf).

<sup>133</sup> As noted in the discussion above on building a technical backbone, new programs should also adhere to the digital ecosystem reference design.

<sup>134</sup> See *Interim Report and Third Quarter Recommendations*, NSCAI at 66 (October 2020), <https://www.nscai.gov/previous-reports/>.

<sup>135</sup> The purpose and proposed contents of such a Technology Annex are discussed below.

<sup>136</sup> See recommendations for the IC to increase S&T expertise and intelligence collection in Chapter 5 of this report.

<sup>137</sup> In its response to the 2017 NDAA provision creating USD (R&E), the DoD specified that the new organization would organize around three major themes. The first was an SIAC that would focus on understanding the enemy’s capabilities and vulnerabilities, conducting analysis on our own U.S. capabilities, tracking technology trends across the globe and assessing potential/emerging threats and/or future opportunities that warrant action, that merit investment. However, since the establishment of USD (R&E), the SIAC has been downgraded from a direct report to the Under Secretary and largely focused on examining threat technologies for OSD customers. See *Report to Congress, Restructuring the Department of Defense Acquisition, Technology and Logistics Organization and Chief Management Officer Organization*, U.S. Department of Defense at 8 (August 2017), <https://dod.defense.gov/Portals/1/Documents/pubs/Section-901-FY-2017-NDAA-Report.pdf> [hereinafter 2017 AT&L Reorganization Plan]

<sup>138</sup> USD (R&E) has the mandate and authority to perform this function. See DoDD 5137.02 at 5-6.

<sup>139</sup> This is consistent with a recommendation made in Chapter 3 of this report that the DoD should integrate AI-enabled applications into all major Joint and Service exercises and, as appropriate, into other existing exercises, wargames, experiments, and table-top exercises. See also *Second Quarter Recommendations*, NSCAI at 27 (July 2020), <https://www.nscai.gov/previous-reports/>.

<sup>140</sup> This would also directly support objectives of Section 1102 of the FY2021 NDAA with respect to utilization of public-private talent exchanges. Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021).

<sup>141</sup> For example, via the go-to-market strategy outlined above.

<sup>142</sup> An unclassified version of the strategy must be communicated externally, to where the bulk of the AI talent resides. Shifting to a more integrated and transparent communication of priorities would enable Defense primes and non-traditionals to plan and invest more to help meet DoD R&D needs. See Tab 1 - Issue 3: "Expanding Industry's Role in DoD's AI R&D to Develop Next-Generation Capabilities" in *Interim Report and Third Quarter Recommendations*, NSCAI at 48 (October 2020), <https://www.nscai.gov/previous-reports/>.

<sup>143</sup> This could be done via the reference design for the digital ecosystem outlined above. As stated above, adherence to the reference design should be driven top-down via a memorandum from the Secretary of Defense and enforced through the Joint Requirements Oversight Council (JROC).

<sup>144</sup> For example, under microelectronics, this might include advancing AI multi-chip packages, development of quantifiable assurance, 3D chip stacking, photonics, carbon nanotubes, gallium nitride transistors, domain-specific hardware architecture, electronic design automation, and cryogenic computing. As recommended by NSCAI in our *First Quarter Recommendations*. See *First Quarter Recommendations*, NSCAI at 51 (March 2020), <https://www.nscai.gov/previous-reports/>.

<sup>145</sup> This should be coordinated appropriately with the relevant legal and ethics officials to avoid any potential conflicts of interest.

<sup>146</sup> OUSD (R&E) could leverage existing Intergovernmental Personnel Act authorities as well as the pilot Public-Private Talent Exchange Program. See *Department Of Defense Public-Private Talent Exchange (PPTe) Program: Questions/Answers*, DoD Defense Civilian Personnel Advisory Service (Aug. 23, 2018), [https://www.dcpas.osd.mil/Content/Documents/PPTeQuestions\\_Answers23Aug2018.pdf](https://www.dcpas.osd.mil/Content/Documents/PPTeQuestions_Answers23Aug2018.pdf); Pub. L. 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 134 Stat. 3388 (2021) (directing that the Department of Defense establish public-private exchange programs to support the defense modernization priorities).