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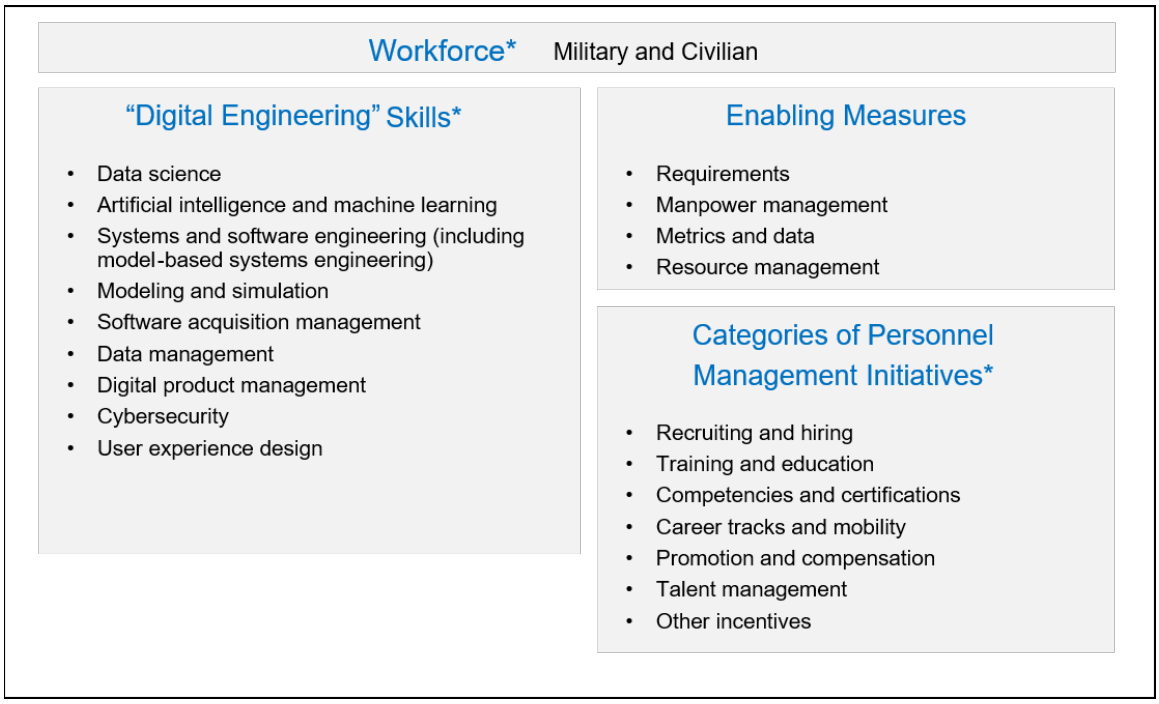
Executive Summary

According to Section 230 of the National Defense Authorization Act for fiscal year (FY) 2020,[1] the Senate directed the Secretary of Defense to commission an independent study "for an identification of policy options and cost-benefit analysis of these options to strengthen digital engineering and related capabilities of the DoD civilian and military workforces."[2] The Secretary asked the Institute for Defense Analyses to perform this analysis.

IDA's analysis covers the broad range of digital engineering (DE) skills, both military and civilian, enumerated by Congress. As defined by Congress, the DE workforce includes a wide array of skills and communities, which are shown in the following figure. To conduct the analysis, the IDA team surveyed previous and ongoing workforce improvement initiatives and proposals and organized them into four areas: (1) necessary enabling measures (establishment of requirements, metrics, resources, and organizations); (2) pipeline programs for new talent; (3) education and training programs; and (4) programs and structures for managing careers, competencies, and compensation. The team then selected 24 candidate initiatives for in-depth analysis of their effectiveness, risk, and costs.

1 Pub. L. 116-92, Section 230, "Policy on the Talent Management of Digital Expertise and Software Professionals."

2 Senate Armed Services Committee, "Digital Engineering as a Core Competency of the Armed Forces," S. Rep. 116-48, https://www.congress.gov/116/crpt/srpt48/CRPT-116srpt48.pdf, 183–184. The specified DE skills are data science, artificial intelligence and machine learning, systems and software engineering (including model-based systems engineering), modeling and simulation, software acquisition management, data management, digital product management, cybersecurity, and user experience design.



Note: *Congress stipulated the definitions of the covered workforce, skills, and initiatives.

Scope of the Analysis

History of DoD Workforce Initiatives

DoD has extensive experience building and maintaining highly skilled workforces in domains such as nuclear weapons and nuclear propulsion, space systems, and specialized medical and legal professionals. Therefore, the IDA team conducted this analysis in the context of multiple current efforts to strengthen DoD's technical workforces, including the Department's cybersecurity, software, intelligence, and acquisition workforces.

The IDA team observed that initiatives to strengthen the DE workforce could build on existing DoD authorities and initiatives. The Congress has authorized a number of education and training programs, including tuition assistance, professional military education, and career training and certification programs (such as those established pursuant to the Defense Acquisition Workforce Improvement Act). Career and compensation authorities include pay banding for laboratory, cyber, and acquisition workforces; increased pay caps for STEM and acquisition workforces; special promotion authority for critical skills; and military and civilian rotation and exchange programs. Other recent DoD activities include restructured classification and credentialing processes for the software engineering and test and evaluation workforces.

Approach

The IDA team reviewed relevant legislation, legislative proposals, the work of independent commissions and panels, and studies and reports developed by IDA and other research centers. Altogether, we examined roughly 40 provisions of existing law, 40 DoD initiatives, 20 provisions of pending legislation, and 130 recommendations of independent studies and reports, for a total of 230 candidate policy initiatives. We chose 24 proposals for in-depth assessment based on four selection criteria: (1) coverage of the full range of designated DE skills across both military and civilian workforces; (2) coverage of the four lines of effort spanning the career life cycle (and enabling measures); (3) inclusion of initiatives that are broadly considered "best practices"; and (4) noteworthy, high-profile recommendations currently under consideration. We evaluated these candidate proposals primarily on their assessed effectiveness, risk, and cost and secondarily on synergies with other proposals and potential implementation issues.

Due to the absence of specific DE workforce requirements and limited data, the IDA team established planning factors rather than firm cost estimates for the selected proposals. This planning information provides a basis for cost-effectiveness tradeoffs in designing a DE workforce improvement program at various scales.

The IDA team did not address increased workforce size as a separate proposal in this paper. A requirements analysis and a manpower analysis (described in Chapter 3) is required to determine whether such an increase is needed, and if so, how large it should be. Nevertheless, it is clear from the cost data we collated that one of the major cost drivers of DE initiatives is the personnel costs associated with expanding the DE workforce. For example, a 5 percent increase in the DE workforce, adding about 5,000 additional personnel, would cost approximately $500 million per year just for salaries.

Observations

Our analysis provides an assessment for each of the 24 selected proposals. The following sections and their accompanying tables summarize the IDA team's assessment of the effectiveness of each proposal in meeting workforce transformation objectives, along with the assessed implementation risks. Most of the initiatives are assessed as effective or highly effective, in large part because these candidates were screened and selected from a much larger set of alternatives. Similarly, in nearly all cases, the risks are low or moderate. Overall, the assessments identify a workable set of building blocks that could be assembled into a cost-effective program to transform the DE workforce.

Enabling Measures

Certain proposed enabling measures for workforce transformation (shown in the table below) are essential for identifying the specific DE skills and communities to be

strengthened, to scope the necessary workforce improvement actions, and to provide the necessary management mechanisms. A requirements analysis would identify and target gaps in DE talent, determine who would fill such gaps, and where in the workforce these individuals would be most effective. Similarly, a manpower management system would ensure that DoD could shape the DE workforce by identifying key competencies and enabling the appropriate mix of military, civilian, and contractor personnel to provide these competencies. Workforce tracking and metrics would also support the deployment of existing talent and assessment of progress toward improving DE capabilities. Likewise, budget and resource management—including the allocation of billets and a central fund to support workforce improvement activities—would help ensure that planned initiatives could be carried out.

Enablers: Requirements & Management

Candidate Proposal	Objective	Effectiveness	Risk
DE workforce requirements analysis	Provide an understanding of the needs for DE talent as the basis for strategy, planning, & effective program execution	HIGHLY EFFECTIVE	MODERATE
DE manpower management	Provide the authority, information, & resources to shape the DE workforce	HIGHLY EFFECTIVE	LOW
Workforce metrics & tracking		HIGHLY EFFECTIVE	MODERATE
Budgeting & resource management		HIGHLY EFFECTIVE	MODERATE

Pipeline for New Talent

Critical to strengthening the DE workforce is the ability to bring in new talent. Most of the pipeline proposals that we considered (shown in the table below) have been proven in previous applications and are expected to be either effective or highly effective, and to carry low or moderate risk. Onboarding costs range from $20,000 to $100,000 per person across the traditional pipeline programs. The creation of special digital recruiting units for the Armed Forces would carry higher risk because of the potential disruption to established recruiting approaches. However, this method could be effective if appropriately implemented. The final proposal we consider—establishing a digital service academy for civilians—would be costly to implement with low marginal effectiveness. A new academic institution would likely find it difficult to compete with established civilian institutions for students and faculty.

Pipeline for New Talent

Candidate Proposal	Objective	Effectiveness	Risk
Hire STEM professors & students for summer breaks	Reach out to academic experts & increase access to highly skilled experts	HIGHLY EFFECTIVE	LOW
Provide fellowships w/stipends & summer employment		EFFECTIVE	LOW
STEM civilian recruiting offices	Provide focus, tools, trained personnel & authorities to overcome barriers to hiring	EFFECTIVE	MODERATE
Digital force recruiting units for uniformed services		EFFECTIVE	HIGH
Cohort hiring		HIGHLY EFFECTIVE	MODERATE
Rotational cadres of digital experts	Strengthen outreach, develop talent, & overcome hiring barriers	HIGHLY EFFECTIVE	LOW
Expanded SMART scholarships & Cyber: Scholarships for Service (C:SFS)		HIGHLY EFFECTIVE	LOW
Defense Civilian Training Corps		EFFECTIVE	MODERATE
Digital Service Academy for Civilians		QUESTIONABLY EFFECTIVE	HIGH

Education and Training

DoD can draw heavily on established military and civilian providers for education and training across the spectrum of identified DE fields. Education and training costs are largely determined by the extent to which the workforce would be compensated for its time. One training mechanism we considered is boot camps, which are intensive residential programs, and so are relatively costly. The per-graduate cost is estimated to range from approximately $18,000 to $32,000. In contrast, reimbursements for coursework covering only tuition are relatively inexpensive but require careful management to ensure effectiveness. The Defense Acquisition Workforce Development Fund (DAWDF) currently provides about $1,500 per year on average in reimbursed training costs for the acquisition workforce. The DAWDF is managed by the Human Capital Initiatives (HCI) office within the Office of the Under Secretary of Defense for Acquisition & Sustainment (OUSD(A&S)) and by the Directors for Acquisition Career Management (DACMs) of the individual Services. Another training option we assessed is mandatory, universal DE training. The IDA team determined that this approach is unlikely to be effective due to the wide variation in experience levels and responsibilities across the Department, and it would

be quite costly given the opportunity cost of participants' time. These training options are shown in the table below.

Education and Training

Candidate Proposal	Objective	Effectiveness	Risk
Digital boot camps	Provide intensive, residential training in focused skill areas	EFFECTIVE	MODERATE
Reimbursed online education & training	Provide opportunities for self-initiated training	EFFECTIVE	LOW
DoD-wide mandatory training	Provide introductory training for all DoD	QUESTIONABLY EFFECTIVE	HIGH

Careers, Competencies, and Compensation

Any pay increase large enough to serve as an incentive, and applied to enough people to make a significant difference, would necessarily be costly. For example, consider DoD's current pay premiums for technical positions in the acquisition workforce pay plan (AcqDemo). These salaries are estimated to average about 5 percent above the General Schedule. Within the military, special pays average about 9 percent of base pay. These alternative pays can be highly effective as incentives to attract and retain talent. Both workforce talent management and targeted career enhancement initiatives are relatively low in cost and risk, and could be implemented in conjunction with the enabling measures described in Chapter 3. See the table below.

Careers, Competencies, & Compensation

Candidate Proposal	Objective	Effectiveness	Risk
Functional Career Managers	Identify and enable the management of critical skills	EFFECTIVE	LOW
New military occupational specialties		EFFECTIVE	MODERATE
New civilian career fields		EFFECTIVE	MODERATE
Credential-based skills tracking		HIGHLY EFFECTIVE	MODERATE
Special market-based pay for civilians	Foster recruitment & retention through competitive compensation	HIGHLY EFFECTIVE	LOW
Special pays for military		EFFECTIVE	LOW
Expanded public-private exchange	Provide career progression & mobility	EFFECTIVE	LOW
Civilian rotational career paths		EFFECTIVE	MODERATE

Next Steps: Toward an Effective and Efficient DE Workforce Improvement Program

Our analysis contributes to the analytical basis for a cost-effective strategy to strengthen the DE workforce. The assessments confirm that there are proven building blocks for each of the four lines of effort. Indeed, DoD has extensive experience building workforces with specialized talent where the requirement is established. The Congress has already provided DoD with numerous special authorities, and significant efforts are underway that directly or indirectly address the DE workforce. The cost planning factors—while tentative—suggest that substantial resources may be required, and important tradeoffs will need to be analyzed and decided. However, more work will be needed to merge these building blocks into a coherent program. The essential next step is to determine DoD's DE workforce requirements—that is, the variety of skills and the numbers and mix of personnel needed—in order to define and execute a coherent set of workforce improvement actions.

Contents

1. Introduction

A. Congressional Tasking—An Independent Survey and Evaluation of Candidate Actions

In June 2018, the Under Secretary of Defense for Research and Engineering issued a new digital engineering (DE) strategy for the Department of Defense (DoD). The strategy recognized that digital technologies have enabled a "paradigm shift" across most major industries and called upon DoD to incorporate technologies such as advanced computing, big data analytics, artificial intelligence (AI), autonomous systems, and robotics to drive similar innovation and problem-solving in the defense sphere. One of the keys to this digital transformation, the strategy stated, would be a geographically dispersed, multidisciplinary, and multigenerational workforce with the knowledge, competence, and skills to adopt new concepts and methods, processes, and tools.[1]

One year later, the Deputy Secretary of Defense issued a digital modernization strategy, which recognized that information technology is "a critical enabler for the command and control of forces executing warfighting operations, management and protection of information assets, and collaboration with mission partners."[2] The digital modernization strategy recognized that the Department's ability to adopt new technology continuously would depend on its success in the ongoing competition for "high-quality, experienced digital workforce personnel."[3]

Independent reports and reviews have reached similar conclusions. For example, the Defense Innovation Board (DIB) reported on May 3, 2019, that "[s]oftware is made by people and for people, so digital talent matters" and that "new mechanisms are needed for attracting, educating, retaining, and promoting digital talent."[4] Similarly, the National Security Commission on Artificial Intelligence (NSCAI) reported in March 2020 that in a

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1 Office of the Deputy Assistant Secretary of Defense for Systems Engineering, *Digital Engineering Strategy,* June 2018, fas.org/man/eprint/digeng-2018.pdf, 22–23.

2 Department of Defense (DoD), *DoD Digital Modernization Strategy,* July 12, 2019, https://media.defense.gov/2019/Jul/12/2002156622/-1/-1/1/DOD-DIGITAL-MODERNIZATION-STRATEGY-2019.PDF, 33.

3 DoD, *DoD Digital Modernization Strategy,* July 12, 2019, https://media.defense.gov/2019/Jul/12/2002156622/-1/-1/1/DOD-DIGITAL-MODERNIZATION-STRATEGY-2019.PDF, 33.

4 Defense Innovation Board (DIB), *Software Is Never Done: Refactoring the Acquisition Code for Competitive Advantage,* May 3, 2019, https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/SOFTWAREISNEVERDONE_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE_FINAL.SWAP.REPORT.PDF, i.

strategic competition, the advantage will go to the competitor that can best attract, train, and retain world-class technical talent. For this reason, the NSCAI concluded, defense and intelligence agencies should place a high priority on expanded digital skills and expertise, "including software engineers, data engineers and scientists, mathematicians, and machine learning experts."[5]

To address these issues, the Senate report accompanying S. 1790, the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020, directed DoD to promote and develop a core competency in DE and related digital competencies (including data science, machine learning, software engineering, software product management, and user experience design). In particular, the Senate report called upon the Department "to enter into an arrangement with an independent research organization or study board for an identification of policy options and cost-benefit analysis of these options to strengthen digital engineering and related capabilities of the DoD civilian and military workforces."[6] The Institute for Defense Analyses was asked to perform this analysis.

The Senate-directed study requirement is best understood in the context of section 230 of the FY 2020 NDAA.[7] That provision defines DE to include "the discipline and set of skills involved in the creation, processing, transmission, integration, and storage of digital data, including data science, machine learning, software engineering, software product management, and artificial intelligence product management." In addition, it calls for policy measures addressing "the recruitment, development, and incentivization of retention in and to the civilian and military workforce of the department" and "at the discretion of the Secretaries of the military departments, the development and maintenance of civilian and military career tracks… including the development and maintenance of training, education, talent management, incentives, and promotion policies in support of members at all levels of such career tracks."[8]

As summarized in Figure 1, this analysis is scoped in accordance with section 230, covers the broad range of DE skills specified by the Congress, and addresses both the military and civilian workforce. For each workforce, the analysis addresses options over the entire career life cycle as described in the legislation. In addition, our assessment considers a number of enabling actions to define requirements and manage a program of workforce improvement initiatives. The IDA team organized the survey of program alternatives using four major categories: (1) enabling measures, such as defining workforce

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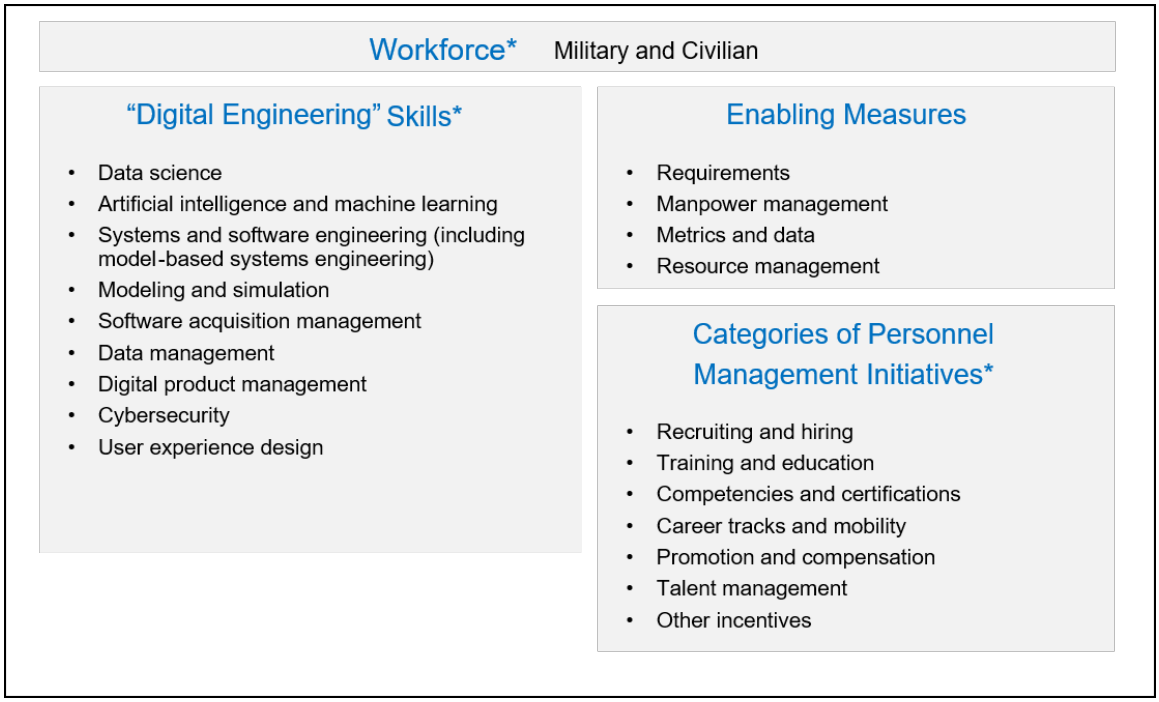
5 National Security Commission on Artificial Intelligence, *First Quarter Recommendations*, March 2020, https://drive.google.com/file/d/1wkPh8Gb5drBrKBg6OhGu5oNaTEERbKss/view, 21.

6 Senate Armed Services Committee, "Digital Engineering as a Core Competency of the Armed Forces," S. Rep. 116-48, https://www.congress.gov/116/crpt/srpt48/CRPT-116srpt48.pdf, 183–184.

7 "Policy on the Talent Management of Digital Expertise and Software Professionals," Pub. L. 116-92, Section 230.

8 "Policy on Talent Management."

structure, assessing DoD's skill and experience requirements, and establishing workforce data and metrics; (2) reforming the pipeline for new talent; (3) bolstering education and training; and (4) strengthening the management of careers, competencies, and compensation. These categories provide the overall framework for a coherent program that spans the career life cycle.



Note: *Congress stipulated the definitions of the covered workforce, skills, and initiatives.

Figure 1. Scope of the Analysis

B. Context

DoD has long-standing experience with building specialized, highly skilled workforces when necessary. Some noteworthy examples include the personnel responsible for nuclear weapons and propulsion systems, space systems, DoD laboratories, and defense acquisition programs, as well as the medical and legal professions. The challenge for designing initiatives to strengthen the DE workforce is to learn from past efforts in order to institute effective and efficient policies and programs now and in the future.

Beyond the focus on specialized skills and occupations, the Congress has taken several steps to provide DoD with substantial authority and flexibility to build and manage the DoD technical workforce, extending back to the Defense Acquisition Workforce

Improvements Act (DAWIA) of 1991.[9] Over the past two decades, the Congress has expanded authorities to improve DoD's flexibility for outreach, hiring, education, and workforce career management focused on the acquisition workforce, the DoD laboratories, and the cyber workforce. Recent legislation has accelerated these efforts by establishing new authorities and programs across all the phases of the career life cycle.

Appendix A provides references to specific congressional actions. Pipeline initiatives include Science, Mathematics, and Research for Transformation (SMART) scholarships, Technology and National Security Fellowships, direct appointment authority for cyber and laboratories, direct appointment authority for hiring recent graduates, hiring authority for "highly qualified experts," and authority for direct commissioning of officers in cyber along with lateral entry for mid-career cyber experts. This year, the Congress directed the establishment of a Defense Civilian Training Corps, a civilian parallel to traditional Reserve Officers' Training Corps (ROTC) programs.

The Congress has also authorized a number of education and training programs, including tuition assistance, professional military education, and career training and certification programs (such as those established pursuant to DAWIA). Career and compensation authorities include pay banding for laboratory, cyber, and acquisition workforces; increased pay caps for STEM and acquisition workforces; special promotion authority for critical skills; new flexibilities for military careers; and authority for military and civilian rotation and exchange programs.

Within DoD, several ongoing actions that address the Department's technical workforce directly or indirectly strengthen the DE workforce. Initiatives addressing the Defense Acquisition Workforce and the DoD Laboratory Workforce are the most long-standing and ambitious examples. Other, recent initiatives address functional career areas. For example, there is a software engineering workforce working group and a test and evaluation workforce task force. Other areas being addressed include the intelligence workforce, AI, and the workforce responsible for model-based systems engineering. Actions that have specifically addressed the DE workforce include:

- A new working group that reports to the Under Secretary of Defense for Personnel and Readiness that plans to establish broad civilian workforce skill coding
- A new Defense Acquisition University (DAU) credential for DE

The IDA team finds there is substantial potential overlap between the DE workforce and the communities being addressed through the initiatives identified above. These community-focused initiatives are moving in parallel; most are still being designed and

[9] "Defense Acquisition Workforce Improvement Act," *National Defense Authorization Act for Fiscal Year 1991*, Pub. L. 101-510, Title XII, November 5, 1990.

none is yet fully implemented. The IDA team surveyed these initiatives in order to understand the kinds of workforce improvement actions that have been tried or proposed. In addition, our analysis will help ensure that DE improvement initiatives complement other efforts.

2. Approach

A. Identification of Candidate Proposals

The purpose of this analysis is to identify proposals that could contribute to an effective and efficient DE workforce improvement initiative. As the basis for this, the IDA team reviewed existing and proposed actions that address DoD's well-recognized challenges and barriers to building specialized skill communities. This effort included a survey of recent legislation, legislative proposals, the work of independent commissions and panels, and studies and reports developed by IDA and other federally funded research and development centers (FFRDCs). Altogether, the IDA team reviewed roughly 40 provisions of existing law, 40 DoD initiatives, 20 provisions of pending legislation, and 130 recommendations of independent studies and reports, for a total of 230 proposed policy initiatives.[10] The studies and reports reviewed by the IDA team are listed in Table 1; the relevant initiatives in each report are briefly summarized in Appendix A.

Table 1. Studies and Reports in the IDA Team Survey

Study Commissions and Panels	
• Defense Innovation Board, "Software Acquisition and Practices"	• National Security Commission on Artificial Intelligence Q1
• National Commission on Military and National Public Service	• Section 809 Panel, "Streamlining and Codifying Acquisition"
• Force of the Future	• Cyberspace Solarium Commission Report
• Defense Science Board Software Acquisition Report	• National Academy for Public Service, "No Time to Wait: Part 2"
• Partnership for Public Service, "Mobilizing Tech Talent"	

Reports
• David Tate, "Software Productivity," *Defense ARJ*, Vol. 27 No. 2 (April 2020): 157
• Peter Levine, The National Security Personnel System, IDA Paper NS P-8586
• Victoria Pena, *Tour of Duty Hiring*, IDA Paper NS D-10700
• Sean Robson, Bonnie Triezenberg, Samantha DiNicola, Lindsey Polley, John Davis, II, and Maria Lytell, Software Acquisition Workforce Initiative for the Department of Defense: Initial Competency Development and Preparation for Validation, RAND Corporation, RR-3145-OSD, 2020

[10] This report includes legislative proposals through FY 2020.

The IDA team applied four major criteria to identify candidate initiatives for more detailed examination in this report. First, we selected options that would span the breadth of DE skills for both the military and civilian workforces. Second, the IDA team covered the four major lines of effort in a strategy to strengthen the DE workforce: enabling capabilities; recruiting and hiring; training and education; and careers, competencies, and certifications. Third, the IDA team identified candidate initiatives consistent with the themes having consensus support as best practices for workforce strengthening. Most of these initiatives were proposed by more than one source. Finally, a few noteworthy, high-profile recommendations are included, even though a consensus of support has not emerged; for example, a civilian DE academy.

This narrowing process resulted in 24 candidate proposals for further review. Table 2 lists the candidate proposals, categorized into the four lines of effort described earlier and 11 subcategories of functions within these lines of effort.

Table 2. Candidate Proposals Aligned with Common Themes of Studies and Reports

Categories of Initiatives	Candidate Proposals
Enablers	
• Requirements: Provide an understanding of the needs for DE talent as the basis for strategy, planning, & effective program execution	1. DE workforce requirements analysis
• Management Structures & Information: Provide the authority, resources, & information to shape the DE workforce	2. DE manpower management 3. Workforce definition, metrics, & tracking 4. Budgeting & resource management
Pipeline	
• Outreach: Engage with academic experts & students to access talent & foster interest in DoD careers	1. Hire STEM professors & students for summer breaks 2. Provide fellowships w/stipends & summer employment
• Hiring: Provide focus, tools, knowledgeable personnel, & authorities to overcome barriers to hiring	3. STEM civilian recruiting offices 4. Digital force recruiting units for uniformed services 5. Cohort hiring
• Blended Outreach & Hiring: Strengthen engagement, invest in talent, & overcome hiring barriers	6. Rotational cadres of digital experts 7. Expanded SMART scholarships & C:SFS 8. Defense Civilian Training Corps 9. Digital Service Academy for Civilians

Education & Training	
• Focused Training: Provide intense residential training for targeted skills	1. Digital boot camps
• Self-Initiated Training: Support individual efforts to develop targeted DE skills	2. Reimbursed online education & training
• General Basic Training: Provide general training to raise awareness	3. DoD-wide mandatory training
Careers, Competencies, & Compensation	
• Competency Management: Create the structure & information needed to manage & incentivize the development of needed skills	1. Functional career managers
	2. New military occupational specialties
	3. New civilian career fields
	4. Credential-based skill tracking
• Competitive Compensation: Provide the levels of pay necessary to attract and retain needed talent	5. Special market-based pay for civilians
	6. Special pays for military
• Career Progression & Mobility: Provide new career pathways with sufficient flexibility to develop, retain, & effectively employ DE expertise	7. Expanded public-private exchange
	8. Civilian rotational career paths

We briefly discuss the three primary evaluation criteria in the remainder of this chapter. First, effectiveness and risk are defined in the next section. We then describe cost methods and the cost planning factors for the analysis. Finally, we conclude our analysis with the treatment of workforce expansion costs.

B. Effectiveness and Risk

The criteria for the IDA team's assessments of effectiveness and risk are largely based on experience with prior applications, previous assessments, and expert opinion—drawing on interviews for previous and ongoing studies. The assessments are, to a large degree, necessarily subjective.

Table 3 provides the scales for scoring effectiveness and risk. As discussed in the introduction, the proposals address the known challenges and barriers to building DoD's skilled workforces. Effectiveness was evaluated in terms of the objective to be met by each proposal. Therefore, the evaluation criteria were tailored specifically to each proposal as discussed in the detailed analyses presented in Chapters 3 through 6. For example, a scholarship-for-service program to strengthen DoD's outreach to selected university students would be judged to be highly effective if the team assessed that it was fully meeting its objective or was likely to do so. A short statement of objectives is provided for

each alternative. The team evaluated risk in terms of the likelihood that a proposal would undermine other DoD programs and objectives, or the likelihood that mistakes in executing the proposal would undermine its effectiveness.

Table 3. Evaluation Scales

Effectiveness	
Highly Effective	Likely to robustly meet the intended objective of the proposed initiative
Effective	Likely to meet the intended objective of the proposed initiative
Questionably Effective	Not likely to meet the intended objective of the proposed initiative or is counterproductive
Risk	
Low Risk	It is likely the proposal can be implemented as intended and not conflict with or undermine other programs and activities
Moderate Risk	There is some risk that the proposal will conflict with other programs and activities or fail to be implemented effectively
High Risk	It is unlikely that the proposal can be implemented without conflicting with other programs and activities, or that it can be implemented effectively

C. Cost Methods and Planning Factors

In addition to assessing the likely effectiveness and risk of the selected proposals, the IDA team provides a rough assessment of their costs. This information provides a basis for weighing the relative merits of the proposals as building blocks for a DE improvement program. Appendix B describes the cost methodology and data sources and summarizes the major findings on costs.

These cost assessments address both the up-front costs of initial implementation and the recurring costs of sustaining the proposals over time. Because of limitations of schedule, budget, and available data, this report includes rough order of magnitude cost planning factors rather than precise cost assessments. In many cases, the cost estimates could draw on previous experience or similar activities to derive estimates. In other cases, costs are based on deductive modeling, and in some cases the estimates are best characterized as planning allowances. We also provide the assumptions underlying these cost assessments. While the IDA cost assessments are not precise, they provide an initial perspective that should help to inform decisions regarding an affordable scope and structure for a DE strategy.

For our analysis, we use OSD-Cost Assessment and Program Evaluation (CAPE)'s Full Cost of Manpower (FCoM) tool to estimate the cost of personnel. FCoM is maintained by CAPE and predicts the full cost for having civilians, military personnel, or contractors

work for the government based on many variables, including grade, location, and special pays. The tool is accessible to anyone with a DoD common access card at https://FCoM.cape.osd.mil/. Table 4 presents a summary of the rough cost findings for each proposal. The table divides the costs into three parts: startup costs, annual per-person costs, and annual fixed costs.

Startup costs are the fixed sum needed to initiate the proposal. Typically, this amount includes analytical efforts, efforts to organize needed data, and the costs of establishing a new organization. Several of the proposals have substantial startup costs. The proposed Digital Service Academy is uniquely expensive, with an estimated startup cost of $800 million. The next most expensive startup cost is for the proposed Defense Civilian Training Corps (DCTC)—an estimated cost of $60 million. The DCTC is similar to existing scholarship-for-service programs under which the government pays for civilian education. However, the DCTC would require establishing a significant presence on many college campuses, which gives rise to these costs.

The annual per-person costs typically include outreach and recruiting programs or training, where cost is closely tied to the number of participants. For example, outreach programs offer significant payments, sometimes in exchange for service commitments. These payments can run into several tens of thousands of dollars per year for participants. The digital service academy is an outlier, with an estimated cost in excess of $250,000 per year per student. Training is another cost element that is tied to the number of participants, as are skill-based pays and workforce rotational programs.

Finally, annual fixed costs are typically the costs of sustaining an organization. Some examples of this category include the cost of maintaining a recruiting office and establishing a career management office.

Table 4. Cost Planning Factors

Proposal	Startup Activity Costs (000s)	Annual Per-Person Costs (000s)	Annual Fixed Costs (000s)
OSD Management Activity			
Requirements analysis			
DE manpower management			
Workforce metrics & tracking			
Resource management	$10,000		$8,000–$10,000
Definitions of new civilian career fields			
Definitions of new military occupational specialties for software			
Credential-based skills tracking			
Functional Community Managers			
Functional Career Managers (Army, Navy, USAF, Marines, Space, 4th Estate)			$18,000
DE Recruiting Offices			
STEM civilian recruiting offices (Eastern, Central, Western)			$54,000
Digital force recruiting units for uniformed services (Army, Navy, USAF, Marines, Space)			$54,000
Programmatic Proposals			
Hire STEM professors & students for summer breaks		$30–$100	
Provide fellowships w/stipends & summer employment		$50–$70	
Cohort hiring		$18–$36	
Rotational cadres of digital experts		$150–$500	
Expanded SMART scholarships & C:SFS		$50–$70	
Defense Civilian Training Corps	$60,000	$50–$70	
Digital Service Academy for Civilians	$800,000	$250	
Digital boot camps for upskilling military & civilian employees	$250–$1,300	$20–$30	
DoD reimbursed coursework		$0–$8	
Mandatory digital training for all DoD employees		$0.05	
Market-based pay for DE civilians		$5–$10	
Special pays for DE military		$9–$15	
Expanded public-private exchange		$15–$20	
Civilian rotational career paths		$5–$10	

D. Workforce Expansion Costs

The cost factors provided for the 24 selected proposals are agnostic as to the size of the workforce. Even proposals that are estimated on a per-person basis could be applied either to the existing workforce (i.e., by funneling new recruits into the workforce or providing additional training to the workforce without increasing workforce size) or to an expanded workforce. Nevertheless, it is clear from the cost data we generated for this study that one of the major cost drivers of DE initiatives is the personnel costs associated with any decision to expand the DE workforce. Increased workforce size is not addressed as a separate proposal in this paper, because a requirements analysis and a manpower analysis (described in Chapter 3) would be needed to determine whether such an increase is needed, and if so, how large it should be.

The IDA team assesses that DoD's current workforce with DE-relevant skills consists of roughly 100,000 people. Of those, roughly three quarters are civilians, distributed more or less equally among General Schedule (GS) civilians and civilians on other pay scales such as AcqDemo or the Science and Technology Reinvention Laboratory (STRL) Personnel Demonstration Project. The remaining quarter are military, with enlisted personnel outnumbering military officers by a ratio of about three or four to one.[11] While these numbers are necessarily imprecise, because they are based on job codes that are a poor match for actual DE codes, they do define the scale of the issues.

The costs of any decision to increase the overall size of the DE workforce could be substantial. For example, a 5 percent increase in the size of the DE workforce, or about 5,000 additional personnel, would cost approximately $500 million per year; a 10 percent increase in the size of the DE workforce, or about 10,000 additional personnel, would cost approximately $1 billion per year. By comparison, the IDA team assesses that the Department could implement all of the selected proposals (other than the Digital Service Academy) within the existing workforce at an annual cost of less than $500 million.

A thorough requirements analysis might discover a need for even greater workforce expansion. A recent article by one of the authors[12] estimated that there is a large and growing gap between the number of software developers available to support the development and maintenance of national security software[13] and the number needed. That

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[11] These are rough numbers because we used Military Occupational Specialty (MOS) and occupation codes to identify potential digital engineers. We did not account for some digital engineers but counted others who are not actually digital engineers. Improving these data is one of the proposals that we considered.

[12] David Tate, "Software Productivity Trends and Issues," *Defense Acquisition Research Journal* 27, no. 2 (April 2020): 142–167.

[13] For this analysis, the "available workforce" consists of military and civilian personnel of the Department of Defense, Department of Energy, Department of Homeland Security, national laboratories, etc., as well as members of the contractor workforce possessing security clearances.

article estimates that the shortfall may already be on the order of 150,000 developers and suggests that market forces are unlikely to remedy this shortfall any time soon. While the necessary workers could be military, civilian, or contractor personnel, there are reasons to believe that the contractor base will be unable to supply all of them. As a result, it is possible that DoD may need to expand its organic workforce by numbers in the multiple tens of thousands to address shortfalls in the software development workforce alone.

The remainder of this report addresses the 24 candidate proposals. Chapters 3 through 6 summarize the detailed proposal assessments, organized into four lines of effort for strengthening the DE workforce. Chapter 7 summarizes our assessment and discusses next steps.

3. Enablers: Requirements and Management

As discussed earlier, if the Department embarks on workforce-building efforts without first establishing a strategy and a management approach, it risks acquiring too much of the wrong type of talent, and perhaps leaving gaps elsewhere in its digital capabilities. Moreover, without a requirements analysis, the Department will find it difficult to justify new positions or the budget needed to maintain them. A real risk exists that DoD could build a pipeline of new talent without a place to put it. In short, unless the Department identifies and manages its requirements (along with needed billets and budget), it is unlikely to make progress toward a more effective digital workforce.

The IDA team assesses that a sound DE strategy and management approach would include at least four major elements: requirements analysis; manpower management; DE workforce structuring, metrics, and tracking; and management of resources associated with the DE workforce initiatives. These four major enablers for a sound approach to building the DE workforce are presented as candidate proposals. Each action is discussed in turn; however, these are interrelated functions and should be managed accordingly. Hence, a consolidated discussion of structure, costs, and implementation is provided at the end of this chapter.

A. Proposal 1: Requirements Analysis

1. Description

The first proposal examined by the IDA team is a requirements analysis to identify the capability gaps of the current and projected digital workforce: what skills are needed, who will provide them, how the workforce will be structured, and what new or existing billets and positions they should occupy.

A necessary first step in the requirements analysis is to define the DE workforce. At this point, the term "digital engineer" is not well-defined, and thus the requirements analysis would need to provide a definition. The DE workforce could be defined by competencies; that is, by knowledge, skills, and experience (KSEs). Alternatively, the definition could use job/occupation/Military Occupational Specialty (MOS) categories.

The relevance of these alternative definitions depends on the requirements for the workforce and the nature of the workforce improvement initiatives. For example, the improvements might best be accomplished by (1) increasing the number of people in existing jobs that would traditionally be considered DE, (2) providing additional DE

training for people in jobs that would traditionally be considered DE, (3) adding DE skill qualifications to jobs that were not considered DE in the past (i.e., a job that has become more technical over time) but are acquiring DE requirements, or (4) establishing completely new occupational communities specializing in DE.

Conceptually, the requirements for DE KSEs follow from DoD's strategy and concept of operations for fulfilling the National Military Strategy (NMS). Drawing on DoD's lines of effort to support the NMS and its assigned roles and missions, DoD's major components identify the tasks, functions, and concepts of operations for successfully executing their responsibilities, as shown in Figure 2.

Determining DE KSEs is one element each component should consider when analyzing its required workforce capabilities for executing the identified tasks, functions, and concepts of operation. (In practice, steps for determining each workforce's requirement occur interactively through a process of informed iteration, as skill requirements are balanced against feasibility considerations and resource constraints.) Taking a "Total Force" perspective, the required KSEs can be allocated among military, civilian, and commercial sources of talent.

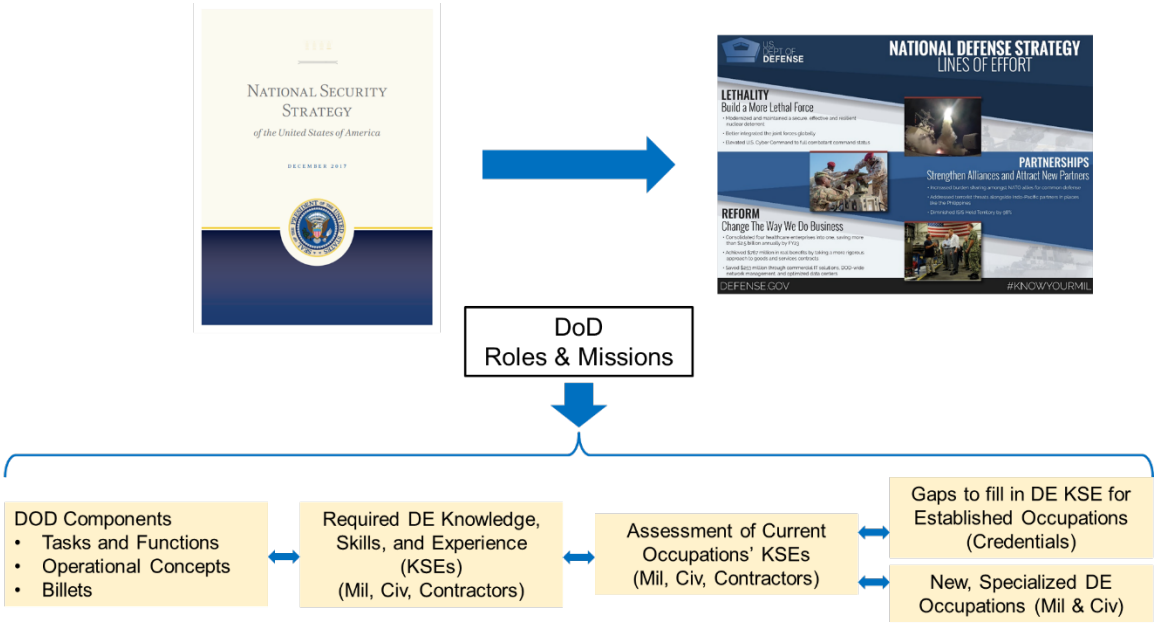

Figure 2. Requirements Flow

Determining KSE requirements provides the basis for assessing the capabilities of personnel in established military and civilian occupations. Such an assessment identifies the KSE areas that are well served by current occupations, occupations where enhancements are needed, and areas where current occupations do not meet KSE requirements.

2. Gaps and Objectives Addressed

The general requirements to create a "core competency" and a "strengthened capability" may be sound objectives—but what skills does DoD need, and how would they best be provided? Specifically:

- What capability does DoD need and what workforce is required to support that capability?
- What mix of digital skills, and in what quantities, is needed to address current and foreseeable gaps?
- For each identified skill, what levels of expertise are needed and in what numbers? Would these be best provided by military personnel, civilians, FFRDCs and university-affiliated research centers, or contractors?
- To the extent that military or civilians are preferred, does the Department need to establish new positions and roles or upgrade skills related to existing positions and roles?
- To the extent that contractors are the preferred option, what new skills are needed in the acquisition workforce, and in what quantities, to best access and supervise those contractors?

Without answers to these questions, any proposed initiative risks creating the wrong workforce: low-end skills where high-end skills are needed, employees with skills that do not meet the requirements for existing billets, and individuals with service obligations but no appropriate positions in which to satisfy them. This is true across all domains of personnel policy: recruiting, education, training, talent management, career development strategies, retention, tracking, and so on. It will be difficult for the Department to choose effective policies without identifying development objectives first. Answering these questions is DoD's responsibility and is beyond the scope of our analysis.

3. Effectiveness

The IDA team determined that a requirements analysis would be **highly effective**. Assessing requirements for DE skills is a necessary enabling function for designing the DE workforce improvement strategy and program. A requirements determination process, as outlined previously, serves to:

- Identify established military and civilian occupations that could be targeted by DE enhancement initiatives to meet mission requirements better
- Establish the gaps in KSEs that need to be filled in established occupations

- Identify new, specialized occupations that would provide needed KSEs and define the nature and scope of KSEs to be provided by members in such occupations
- Provide a basis for estimating the rough scale of the workforce within such occupations

4. Risk

The major uncertainty is in the ability to gain the support of the organizations across DoD that would be involved in assembling the data for estimating requirements. With the proper leadership, this is **a moderate risk** undertaking.

5. Implementation Issues

This task involves significant data collection and analysis. A substantial effort, coordinated across the Department, is required to assemble the needed data and requires a focused leadership team.

6. Synergies

An understanding of requirements is essential to inform all of the other proposals.

B. Proposal 2: DE Manpower Management

1. Description

The second proposal examined by the IDA team is the management of DE manpower. Manpower analyses relate to the sizing of the workforce and the allocation of new military or civilian positions (or the replacement of existing force structure with new military or civilian positions). Nearly all of the alternatives currently being implemented or that have been proposed previously involve some degree of reorganization and expansion of the DE workforce. Although the results of the requirements analysis are needed to specify the numbers and types of positions required in specific organizations, it is possible to assess in the abstract the preferred mechanisms and associated costs for creating or converting new civilian positions and military billets.

2. Gaps and Objectives Addressed

As noted earlier, the DE workforce improvement initiatives will include actions to strengthen DE within established occupations. However, we expect that some growth in the DoD workforce will likely be necessary to execute the initiatives. The initiatives will create some new functions, possibly new DE occupational specialties, and additional educational and training demands for individuals in relevant, established occupations. The

second enabling capability is the need to expand the workforce in several areas sufficiently to support the proposed innovations. The main areas of expansion are highlighted in Figure 3.

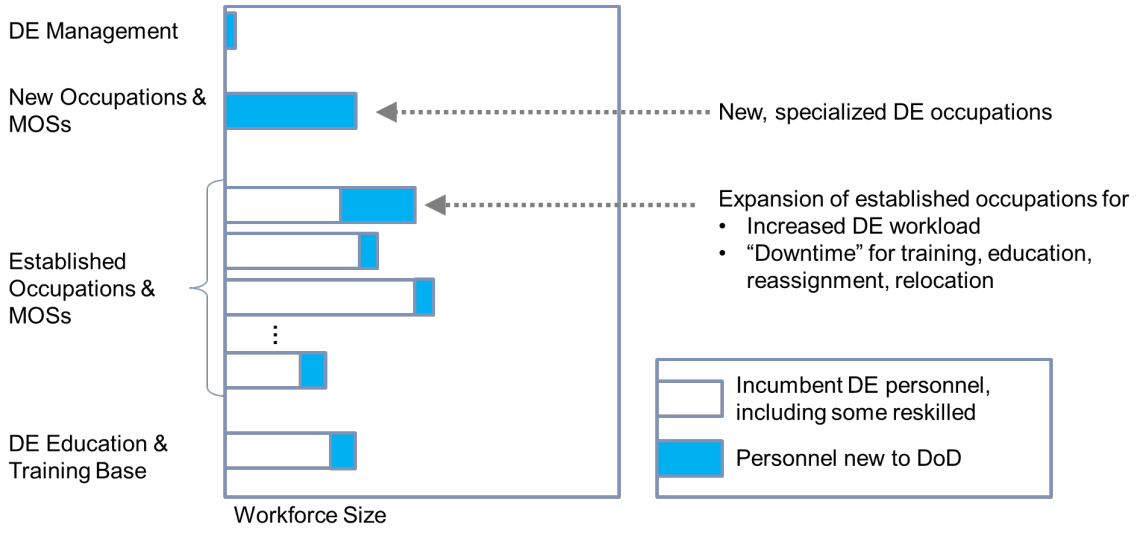

Figure 3. Workforce Implications – Notional Data

The following sections expand on the concepts in Figure 3:

- DE workforce management structure. The necessary top-level DE workforce management structure will be modest in size, but nonetheless critical for the success of the intended workforce improvements.
- New, specialized DE occupations. Possible examples of new, specialized DE occupations include:
  - Digital data management
  - Systems and software engineering
  - AI technology and applications
- Expansion of established occupations. Because the DE initiatives require significant training across the workforce—both for new and established occupations—an allowance will need to be made for the opportunity cost of individuals' time spent in training activities. In addition, several workforce management initiatives involve career moves or rotational assignments that create friction and downtime in careers. An allowance may be needed to offset the productivity losses incurred through such actions. (This is similar in intent to the military Services' Trainees, Transients, Holdees, and Students (TTHS) accounts, which set aside additional manpower to reflect the reductions in available manpower due to friction and lost productivity.)

- Establishment of Education and Training. Finally, additional staff will be needed to support the DE education and training base. The extent of this will depend on the overall scale of the education and training efforts, the degree to which existing offerings can be adapted to meet future DE needs, and the extent to which DoD relies on government personnel instead of employing academic and commercial education and training organizations.

3. Effectiveness

The IDA team assesses that this enabling function would also be **highly effective**. A systematic assessment of the manpower requirements for executing DE workforce strengthening options will provide the basis for well-informed decisions on which proposals to undertake. In addition, this information will provide the basis for the Department's leadership to secure and allocate the necessary resources for implementing the strategy.

4. Risk

There are, of course, challenges when trying to coordinate activities across DoD, but with the proper leadership, this is a **low risk** undertaking.

5. Implementation Issues

The large potential costs associated with expanding the DE workforce present a major issue for implementing a DE workforce improvement strategy. Given the intensely competitive U.S. market for digital talent, DoD will need to offer competitive pay to recruit and retain individuals in the DoD workforce. The required resources will likely be quite large—perhaps on the order of magnitude of those committed to expanding and strengthening DoD's acquisition workforce, which has been funded at about $500 million/year for over a decade.[14]

6. Synergies

The ability to expand the DE workforce will have strong synergies with all of the proposals.

[14] Office of the Undersecretary of Defense for Acquisition and Sustainment (OUSD(A&S)), Human Capital Initiatives, "Department of Defense Acquisition Workforce Development Fund: FY 2019 Annual Report," May 2020. See also previous issues from FY 2008 through FY 2018.

C. Proposal 3: Workforce Metrics and Tracking

1. Description

A key enabler for all alternatives we considered is the ability to identify and track digital expertise available to DoD, both organically and through enduring relationships with supporting organizations. Several working groups and task forces currently grapple with this problem and find that the existing taxonomies for occupational series, position descriptions, and MOS codes correspond poorly (if at all) to relevant DE and software skills. In their 2019 *Software is Never Done* report, the DIB strongly advocated that the Department "[c]reate mechanisms for tracking software development expertise and use" and "create a database of individuals in enlisted, officer, reserve, and civilian positions with software development skills and experience" to inform and support both recruiting and promotion decisions.[15] The RAND Corporation noted in their appendix to the FY 2020 Section 862 report[16] that efforts to identify and characterize software competencies in the DoD workforce, and to uncover potential training and competency gaps, cannot move forward without first identifying the target workforce. OUSD(A&S) concurred, saying:

> Identifying the software acquisition and software developer workforce is critical to determining gaps, deploying training and certifications, and performing key talent management functions. DoD government professionals executing software acquisition and software development roles and functions are not systematically tracked in DoD. Acquisition professionals are currently identified in personnel data with a discrete data element. However, the subset of that workforce that has software expertise, has a need for software expertise, or is in a position that requires performance of software functions is not separately tracked. The identification of software developers is also challenging because there is currently no separate career track for these professionals and therefore no way to track them.[17]

Software is not unique in this regard. For most of the DE skill areas enumerated in the Senate report, there is currently no reliable mechanism to identify who in the Department (uniformed or civilian) uses that skill in their current position, what training they have had in that skill, or which skills would most enhance their ability to perform their current duties.

This proposal calls for the establishment of one or more overarching skill-tracking and career management structures to improve the recruiting, placement, training, and talent

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15 DIB, *Software Is Never Done*.

16 OUSD(A&S), *Initial Report to Congress on FY20 NDAA Section 862(B)(1)(a) Software Development and Software Acquisition Training and Management Programs*, August 2020.

17 OUSD(A&S), *Initial Report to Congress on FY20 NDAA Section 862(B)(1)(a)*, B8.

management of personnel who use (or should use) DE skills. There are several possible frameworks to choose from, as we discuss next.

2. Gaps and Objectives Addressed

The key challenge to improving DoD DE capabilities is not necessarily recruiting people with the desired skills or training the existing workforce in those skills. Those efforts are necessary, but not sufficient. Rather, the primary barrier to effective DE capability is knowing what skills are needed where, and then putting people with those skills into positions where they can exercise the skills effectively to accomplish DoD's mission. This requirement cuts across all DE skill areas and all career management phases.

For military personnel, workforce talent management has traditionally been based around an MOS,[18] which is a taxonomy of professional specialties within each Service. Almost every MOS is organized by *career fields*, but that term is somewhat misleading. Nearly all career fields are based on the specific operational or support domains to which those personnel are assigned, rather than the core skills they carry from posting to posting. Army career fields are grouped into more than 30 *branches* (comprising both officers and enlisted personnel) and *functional areas* (FAs) (for officers only). Functional areas include the Artillery Branch, Aviation Branch, Military Police Branch, Army Acquisition Corps, Special Forces, Cyber Branch, and Civil Affairs Branch. Only a small number of branches are distinguished by a technical competency set that is independent of the specific defense mission applications, or by associated nonmilitary skill requirements that are unique to that branch. These exceptions include the Corps of Engineers Branch, Information Network Engineering FA, Judge Advocate General Branch, Finance and Comptroller Branch, Adjutant General Branch, Operations Research/Systems Analysis (ORSA) FA, Army Acquisition Corps, Simulation Operations FA, Chaplain Branch, and the 11 Medical Department Branches. Of these, only three FAs (Information Network Engineering, ORSA, and Simulation Operations) align closely with a digital engineering skill set, meaning that there are no recognizably DE career paths for enlisted soldiers.

The Air Force likewise groups careers into high-level bundles: Operations, Maintenance and Logistics, Support, Medical, Professional, Acquisition, and Special Investigations. Within the Support category (Category 3) are two technical subcategories for enlisted airmen: Cyberspace Support (3D) and Civil Engineering (3E). Cyberspace Support includes some specialties that align with DE skill areas: Knowledge Operations Management (3D0X1), Cyber Surety (3D0X3), and Computer Systems Programming

[18] MOS is the term used by the Army and the Marine Corps. The Air Force categorizes airmen by Air Force Specialty Code (AFSC), while the Navy uses a system of ratings and the Naval Enlisted Classification (NEC) taxonomy. For convenience, we use the term *MOS* to include all of these personnel classification systems.

(3D0X4). For officers, there is only one potentially DE-aligned specialty, Operations Research Analyst (15AX).

Currently, the Navy is completely redesigning its system of ratings and designators. The current system does not include any career fields or ratings that are recognizably aligned with specific DE skill sets. The Marine Corps has a few MOS related to networks and data systems, but none that align well with DE skill sets called out in the Senate report.

For civilians, positions in the federal government workforce are classified according to a taxonomy of Position Classification Standards (PCS) maintained by the Office of Personnel Management (OPM).[19] Although this taxonomy has evolved over time, its basic structure reflects American industry from 50 years ago. In particular, occupations related to software and other DE specialties have been added piecemeal and inconsistently to the schedule. There is no "software developer" occupation series. Instead, there are scattered subspecialties within the occupation series for Computer Engineering (0854), Computer Science (1550), and Information Technology Management (2210), which are themselves in unrelated primary categories of the taxonomy. The PCS taxonomy is also inconsistent with the Standard Occupational Classification (SOC) taxonomy used by the Bureau of Labor Statistics (BLS) and other agencies for statistical analysis of the U.S. workforce. The SOC taxonomy is central to the O*NET database, a public compilation of occupational data sponsored by the Department of Labor.

O*NET is the state of the art for occupational data analysis and workforce tracking in the United States, combining an updated SOC taxonomy with metadata describing a wide range of worker characteristics and job skill requirements.[20] O*NET takes a cross-functional, attribute-based approach to describing worker requirements, using separate taxonomies of abilities, knowledge, skills, education, experience, and licensing descriptors that are associated with specific occupation codes. Each SOC/attribute combination is assigned an importance value on a scale from 1.0 to 5.0. Thus, for example, knowledge of mathematics is rated an importance of 4.30 for Civil Engineers, but only 2.36 for Distance Learning Managers. Similarly, computer programming skills are rated at 2.0 for Quality Control Systems Managers but 4.0 for Video Game Designers.

This cross-functional approach, which distinguishes the occupation from the skills it uses and the educational or professional requirements it imposes, provides a more flexible analytical framework for examining changing workforce requirements, capability gaps in specific organizations, mismatches between occupational definitions and desired bundles of knowledge and skills, and other workforce talent management metrics. Given the current

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[19] Office of Personnel Management, *Policy, Data, Oversight: Classification & Qualifications*, https://www.opm.gov/policy-data-oversight/classification-qualifications/classifying-general-schedule-positions/#url=Overview.

[20] *The O*NET® Content Model*, https://www.onetcenter.org/content.html, accessed November 7, 2020.

mismatch between civilian occupational descriptions and the skill sets the Department wants to see in its workforce, a skills-based, cross-functional approach to workforce characterization and tracking has definite advantages over purely occupation-based and certification-based approaches. Making a skills-based approach compatible with O*NET would make it easier to measure DoD workforce attributes against the general population and to design public-private exchange programs. Section 6.G, Proposal 23: Credential-Based Skills Tracking, specifically addresses using a cross-cutting, credential-based, skill-tracking system to complement and enable military and civilian talent management in DE-related careers.

3. Effectiveness

The IDA team evaluates this proposal as likely to be **highly effective**, because it is likely **necessary** for long-term success at improving DE skills in the DoD workforce. Skill-based workforce management and tracking have been successfully applied in several parts of the federal workforce. One notable example is the National Initiative for Cybersecurity Education (NICE) Cybersecurity Workforce Framework (NICE Framework), published by the National Institute of Standards and Technology (NIST).[21] The NICE framework

> facilitates the use of a more consistent, comparable, and repeatable approach to select and specify cybersecurity roles for positions within organizations. It also provides a common lexicon that academic institutions can use to develop cybersecurity curricula that better prepares students for current and anticipated cybersecurity workforce needs.[22]

The NICE taxonomy defines seven high-level cybersecurity functional categories, 33 specialty areas of cybersecurity work, and 52 "work roles" with associated, required KSEs.

Career planning, training, and workforce tracking using the NICE framework are provided by the National Initiative for Cybersecurity Careers and Studies (NICCS), which is a unit within the Cybersecurity and Infrastructure Security Agency (CISA). Although this function is housed within the Department of Homeland Security, the intent is for NICCS to support the entire national cybersecurity workforce, not only across all federal agencies but also for students pursuing education toward a government cybersecurity career.

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[21] U.S. Department of Commerce, National Institute for Standards and Technology, *National Initiative for Cybersecurity Education (NICE) Cybersecurity Workforce Framework*, NIST Special Publication 800-181, August 2017.

[22] U.S. Department of Commerce, *NICE Cybersecurity Workforce Framework*.

4. Potential Risks

There are **moderate risks** associated with the implementation of competency models for skills-based DE talent management in the Department. The primary risk areas are associated with:

- Adopting the wrong taxonomy of skills and roles
- Incompatibility with existing career and talent management structures
- Conflicting authorities among stakeholder organizations

These risks are addressed in detail in Section 6.G, Proposal 23: Credential-Based Skills Tracking.

5. Implementation Issues

Because DE skills cut across several career fields, occupations, and organizations, input from several stakeholders is required to develop and maintain a useful taxonomy of skills. Given the list of DE competence areas enumerated by the Senate, it would make sense to have multiple stakeholder groups, each focused on a specific subset of DE. For example, there is no reason that the skills taxonomy for data science and for software development should be developed or managed by the same group. Identifying the best partition of DE competence areas for talent management, workforce tracking, and gap analysis will require considerable thought and the involvement of subject matter experts (SMEs) across a wide range of fields.

6. Synergies with Other Proposals

Several initiatives for enhancing the DoD digital workforce would be significantly enhanced by a more complete and descriptive taxonomy of careers, skills, and work roles across the DE spectrum. In particular, the following proposals could be components of (or would be enabled by) this initiative:

- Proposal 17: Functional career managers
- Proposal 18: New MOSs
- Proposal 19: New civilian career fields
- Proposal 23: Credential-based skills tracking

D. Proposal 4: Resource Management

1. Description

The fourth enabling proposal assessed by the IDA team is a system for budget and resource management. A central fund to support DE workforce improvement activities

would provide a mechanism for instituting needed actions across DoD. Without a dedicated funding mechanism, it is questionable whether such actions would be undertaken systematically.

One approach to budget and resource management would be establishing a central funding mechanism modeled on the Defense Acquisition Workforce Development Fund (DAWDF).[23] A quick review of the DAWDF experience helps to illustrate how a central fund for DE workforce development might be structured and provides insights regarding the scale of the required funding shown in Table 5. Since 2008, the DAWDF has invested $5.1 billion in acquisition workforce improvements. This funding has supported four broad categories of activity: education and training; studies, analyses, and tools; recruitment, retention, and recognition; and hiring. The majority of DAWDF funding ($2.7 billion) has supported expanded hiring. DoD expanded the acquisition workforce from 125,000 in 2008 to 180,000 in 2019—an increase of 54,000 personnel.

Table 5. Example: Cumulative DAWDF Outlays, 2008–2019 ($ millions)

Education and training	Studies, analysis, tools	Recruitment, retention, recognition	Hiring
$ 1,982.1	$ 36.4	$ 363.2	$ 2,721.6

Note: These outlay data provide rough indicators of the investments required to reshape the acquisition workforce. In particular, since 2008, DoD has spent a total of roughly $11,000 on average for education and training for every member of the acquisition workforce. This works out to about $32,000 on education and training for every additional certified acquisition workforce member. A hiring cost factor can be derived by examining the number of workforce members hired through the DAWDF-funded system. This calculation shows that DoD has spent a total of $172,000 for every member hired with DAWDF funding. (Although the DoD workforce grew by 54,000 members between 2008 and 2019, about 16,000 individuals were hired through the DAWDF-funded program.)

Most of the remaining DAWDF funding ($2.0 billion) has supported a wide range of education and training activities. These activities include technical training modules and academic and leadership development education and training. As one result of these investments in education and training, DoD expanded the certification of the workforce from 108,000 in 2008 to 170,000 in 2019—an increase of 62,000 certified acquisition professionals.

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[23] OUSD(A&S), Human Capital Initiative (HCI), *What We Do: DAWDA*, https://www.hci.mil/what-we-do/DAWDA.html, accessed August 2020. Note that in 2019 the DAWDF "fund" was converted to a congressionally authorized "account" in Pub. L. 116-92, 1010(a)(2)(A), thus creating the Defense Acquisition Workforce Development Account.

2. Gaps and Objectives Addressed

Creating a consolidated resource management activity serves two important purposes. First, it establishes a systematic approach for defining the purposes of the resources and defending them in DoD's resource allocation processes. This approach will help to drive the substantial work needed to define the requirements for the DE workforce, as well as to estimate how much the workforce will grow. Second, the control over funding provides needed influence across DoD components to drive execution of the strategy. Like the other enabling proposals, the resource management approach would fortify workforce initiatives across all DE skills and all aspects of workforce management, including outreach; recruiting and hiring; training and education; and careers, competencies, and compensation.

3. Effectiveness

The IDA team assesses that establishing a central workforce fund would be a **highly effective** mechanism for enhancing the development of the DE workforce. The ability to control and direct resources will greatly influence the execution of the DE strategy across DoD components, and thus substantially improve the prospects for success.

4. Risk

There are, of course, challenges with trying to coordinate activities across DoD. In the case of the acquisition workforce, the military departments have not supported the set-aside of funding in the DAWDF because they see such set asides as imposing an undue, external constraint on their funding discretion. On the contrary, the stakeholders in the affected communities value the set aside—both because it supports their functional needs and because it allows the Services to decide how to spend the money (as long as it goes to the workforce). Given the Services' likely opposition to any workforce improvement set-asides, this proposal is a moderate risk undertaking whose adoption and execution will require careful leadership.

5. Implementation Issues

The large potential costs associated with expanding the DE workforce present a major issue for implementing a DE workforce improvement strategy. The required resources will likely be quite large—perhaps on the order of magnitude of those committed to expanding and strengthening DoD's acquisition workforce, which as noted earlier, has been funded at about $500 million per year for over a decade.

6. Synergies

The ability to expand the DE workforce will have strong synergies with all of the proposals.

E. A Consolidated View of the Enabling Structure, Costs, and Implementation Issues

As this section has emphasized, the successful fulfillment of the Congress's intent to strengthen the DE workforce will require an effective structure for requirements analysis, manpower management, metrics, and resource management. Such a structure could be modeled on DoD's Human Capital Initiatives (HCI), which is responsible for the leadership of the federated DoD structure of implementing the Defense Acquisition Workforce Improvement Act (DAWIA) initiatives. HCI's charter defines the following areas of responsibility:[24]

- Policy and Oversight
- Programs and Resource Management
- Talent Management and Other Initiatives

These responsibilities, and the structure and intent of the DAWIA initiatives overall, closely parallel those for the DE workforce. There are, of course, substantial differences in the scopes and missions of the acquisition workforce and the DE workforce. Nevertheless, the federated structure for implementing DAWIA provides a useful point of departure for designing the leadership structure for the DE initiatives.

1. Costs

The costs of establishing the enabling functions will be driven by four main components. The first includes the personnel costs of staffing the organization. The second is the analytical support available to the organization. At the outset, a substantial analytic effort will be needed to understand the contributions of DE to DoD's mission and to establish requirements for DE skills across civilian and military organizations. The third component cost is the cost of creating and administering an information system for defining, tracking, and assessing metrics for the DE workforce. Finally, a budgeting and resource allocation framework will need to be established for managing the DE initiatives.

Although the HCI experience is useful for identifying needed actions and assessing the likely scope and costs, there are also substantial differences that must be considered. We have noted that the scale of the workforce is different. In addition, the HCI received substantial analytic support from DAU; a comparable DE organization will not have a ready partner for providing similar analytic support. Finally, the DAWIA initiatives benefitted from the clear designation of members of the acquisition workforce. Although such a clear designation will exist for any specialized occupations created under the DE

[24] DoD, *USD(AT&L) Office of Human Capital Initiatives Charter*, November 1, 2015, https://www.hci.mil.

initiatives, a large fraction of the relevant workforce will remain classified under established occupations and will not be so clearly delineated.

2. Implementation Issues

Obtaining resources is a major implementation challenge. It will be important to understand and coordinate the ongoing workforce initiatives across the Department. This effort is one of many ongoing and proposed actions to bolster the technical talent within the DoD workforce. Many recent initiatives are moving in parallel; most are still being designed, and none is yet fully implemented.

4. The Pipeline for New Talent

One approach to strengthening the military and civilian digital workforce is to bring in new talent. The pipeline for new talent can be broken down into three phases:

- Outreach efforts to increase the number of individuals exposed to DoD employment options
- Recruiting efforts to identify and sign up individuals for government service
- Hiring processes to bring new recruits into the workforce

Some alternatives cut across multiple phases of outreach, recruiting, and hiring; for example, by offering to pay for a recruit's education in exchange for a binding service commitment.

The IDA team considered the following nine proposals, which fall into four categories:

- Two **outreach** proposals: (1) hiring STEM professors and students for summer breaks, and (2) providing fellowships with stipends and summer employment
- Two **recruiting** proposals: (1) establishing STEM civilian recruiting offices, and (2) establishing digital force recruiting units for the uniformed services
- Two **hiring** proposals: (1) cohort hiring, and (2) rotational cadres of digital experts
- Three **blended** proposals: (1) expanded scholarship-for-service programs, (2) a digital civilian training corps modeled on the ROTC, and (3) a digital service academy for civilians modeled on the military academies

The IDA team's assessment of the likely levels of effectiveness and risk for these nine proposals is summarized in Table 6. We discuss each proposal in detail after the table.

Table 6. Assessment of Talent Pipeline Proposals

Proposal	Effectiveness	Risk
Outreach: Hire STEM professors & students for summer breaks	HIGHLY EFFECTIVE	LOW
Outreach: Provide fellowships w/stipends & summer employment	MODERATELY EFFECTIVE	LOW
Recruiting: STEM civilian recruiting offices	MODERATELY EFFECTIVE	MODERATE
Recruiting: Digital force recruiting units for uniformed services	MODERATELY EFFECTIVE	HIGH
Hiring: Cohort hiring	HIGHLY EFFECTIVE	MODERATE
Hiring: Rotational cadres of digital experts	HIGHLY EFFECTIVE	LOW
Blended: Expanded SMART scholarships and C:SFS	HIGHLY EFFECTIVE	LOW
Blended: Defense Civilian Training Corps	MODERATELY EFFECTIVE	MODERATE
Blended: Digital Service Academy for Civilians	QUESTIONABLY EFFECTIVE	HIGH

A. Outreach Efforts

DoD has already established extensive STEM-related outreach programs. Collectively, these programs provide an opportunity for the Department to reach out to potential employees beginning as early as kindergarten and extending through graduate school.

The Department's K–12 youth programs, such as JROTC, Starbase, high school apprenticeship programs, and STEM outreach programs in each of the military services and many individual commands, seek to build an interest in STEM fields and an affinity for DoD military and civilian service.

Regarding higher education, the Department seeks to use research funding and summer employment to develop connections with professors and students who may become a source of recruits. Specific outreach tools include internships and fellowships, such as the National Defense Science & Engineering graduate fellowship, the Army Educational Outreach Program apprenticeship program, the Consortium Research Fellows Program, the Naval Research Laboratory Pathways Internship program, and the Naval Research Enterprise internship program. Other federal agencies also use similar programs, such as the NIST graduate fellowship program, to inform students and faculty about the possibilities of government STEM careers.

Proposals to improve DoD outreach for digital talent include expanded internship or fellowship programs and academic rotation programs. For example, the National Security Commission on Artificial Intelligence (NSCAI) suggests that the Department could hire STEM professors and students as part-time researchers during summer breaks in an effort to build better pipelines to academia. Alternatively, the Department could provide fellowships with stipends and defense-related employment during school breaks to talented U.S. graduate students working in DE fields of interest to DoD.

B. Proposal 5: Hire STEM Professors and Students for Summer Breaks

1. Description

The DoD Science and Technology Research Laboratories (STRLs) routinely seek to leverage the expertise of the academic community by entering into contracts and grants with faculty members to engage in research. Some STRLs also hire faculty members on a seasonal basis and bring them into the laboratories to conduct research. These engagements are not only an important source of research; they also build relationships to the academic community that serves as a pipeline for recruiting students with expertise in areas of interest to the Department.

The NSCAI recently proposed institutionalizing this process by establishing a program to hire 10 university professors as part-time researchers at each DoD laboratory, up to 100 professors total. These professors could, in turn, bring in students to assist them in their research projects. The NSCAI explained:

> To create opportunities to interact with students, some private sector companies hire university faculty as summer or part-time researchers. The companies benefit from access to a diverse group of experts that understands and often creates the world's most cutting-edge AI. In turn the companies provide resources, exposure to new techniques, and financial compensation to the professors, sometimes including funding for their university-based lab. When the professors return to teaching, they also expose promising students to the companies' work, creating student awareness and excitement about the available opportunities, a positive perception of the companies, and relationships that encourage student employment upon graduation....
>
> Some government laboratories already hire university professors as part-time researchers. It is unclear how often this happens, the return on investment when it takes place, or how often faculty expose their students to government work, internships, or employment.[25]

[25] NSCAI, "First Quarter Recommendations," March 2020, https://drive.google.com/file/d/1wkPh8Gb5drBrKBg6OhGu5oNaTEERbKss/view, 36.

A provision that would implement the NSCAI recommendation and authorize the temporary hiring of faculty members and students is included in both the House and the Senate version of the *National Defense Authorization Act for Fiscal Year 2021*.[26]

2. Gaps and Objectives Addressed

In addition to AI, faculty and students could be hired temporarily in other digital-related academic disciplines of interest to the Department. These temporary positions would help DoD develop a pipeline for high-end researchers with specialized expertise, which can sometimes be difficult for the Department to access. The summer hire program would be directed exclusively at civilians and would not be expected to affect military recruiting.

3. Cost

The major cost of implementing this proposal would be the salaries for researchers and students. The NSCAI proposal (and the House and Senate provisions) would authorize the Department to pay faculty members up to 150 percent of the salary for Level 1 of the Executive Service (currently approximately $200,000 per year).[27] Student pay would likely be established at a much lower level. In addition, the laboratories would incur costs to make facilities available to faculty and students and to establish programs to educate them about the activities of the research laboratories.

The estimated total cost for an academic to work with the government for a 10-week summer assignment ranges from $30,000 for a student in a low-cost area to $100,000 for an experienced professor in a high-cost area.[28]

4. Effectiveness

The IDA team assesses that this approach is likely to be **highly effective** for accessing small numbers of individuals with elite skills. NSCAI reports that some private sector companies hire university faculty as summer or part-time researchers. When the professors return to teaching, they expose promising students to the companies' work, creating student

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[26] S. 1049, Section 216, https://www.congress.gov/bill/116th-congress/senate-bill/4049/text; H.R. 6395, section 246, https://www.congress.gov/116/crpt/hrpt442/CRPT-116hrpt442.pdf.

[27] Title 10, United States Code, Section 1599h. Personnel management authority to attract experts in science and engineering.

[28] Costs are modeled by direct analogy to an academic summer program run annually by IDA. The data, from the summer of 2019, include salaries for each visitor and travel cost totals by site. IDA's Special Conference on Applied Mathematical Problems program brings in academic visitors, mostly in mathematics but also other related fields, to work on complicated problems for 10 weeks during the summer. The visitors range from promising graduate students to senior faculty members. The visitors receive a salary for their time along with expenses to get onsite and hotel accommodations at one of the three sites: Bowie, MD; La Jolla, CA; and Princeton, NJ.

awareness and excitement about available opportunities, a positive perception of the companies, and relationships that encourage student employment upon graduation.

DoD has similar experience with programs like the OSD Faculty Fellow Research Team Program, the Army Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) Faculty Fellowship Program, the Office of Naval Research Faculty Research Program, and the Air Force Research Lab Summer Faculty Fellowship Program. Laboratory hiring managers report that these programs help them build connections to academic communities to help recruit emerging talent. Although current programs focus on more academic "pure science" disciplines, an expansion to the applied sciences in digital fields such as AI and software development could also be effective.

5. Potential Risks

The IDA team assesses that this is a **low risk** proposal as long as it is applied to academic disciplines for which it is a good fit. Building informal recruiting networks is a proven technique for accessing talent. The development of connections with the academic community through summer work appears to be an effective tool for this purpose.

6. Implementation Issues

Work culture and environment may impede implementation if the Department attempts to expand this program beyond the defense laboratories. The defense laboratories provide a research environment that is conducive to summer employment for faculty members and students. If the Department tries to expand this approach to non-laboratory environments, it may not be a good fit for faculty members who are more interested in research than in applied work such as software development projects.

Candidates may need to wait long periods to receive their security clearances, and this delay should be considered when placing academics in temporary positions. If the program runs on an annual cycle, it is likely that some candidates will miss the opportunity while waiting for their clearances. To mitigate this delay, the process for hiring must be open longer than an annual cycle to accommodate summer employment. Applicants could be offered positions that would be available when their clearances are granted, which might be more than a year away.

7. Synergies with Other Proposals

This outreach approach would benefit from **some synergies** with other academic outreach programs such as Proposal 5 (expanded fellowships) and Proposal 10 (expanded SMART scholarships). Combining outreach through faculty fellowship programs with student scholarships and fellowships would help the Department not only identify up-and-coming talent, but also place them in a pipeline for future hires.

C. Proposal 6: Provide Fellowships with Stipends and Employment

1. Description

Several research labs maintain strong connections with academia by granting undergraduate internships and graduate fellowships to students in specialty areas of interest to the Department. In some cases, the Department even helps shape courses of study and dissertation topics to meet DoD needs. DoD has extensive experience with programs such as the National Defense Science and Engineering Graduate Fellowship; Army Educational Outreach Program apprenticeship program; Consortium Research Fellows Program; NRL Pathways Internship Program; and Naval Research Enterprise Internship Program.[29] DoD personnel specialists in the defense laboratories report that these programs have been extremely successful in allowing organizations to target areas of needed expertise and frequently lead to long-term hires.

The Department could increase its pipeline for academic talent by expanding existing programs under which students are granted internships and fellowships to conduct research or hired on a temporary basis to provide critical skills and expertise. The Partnership for Public Service has recommended bringing students into government temporarily to expose them to the positive aspects of public service. According to the Partnership, the government should "create and support digital fellowships for college students to expose them to the power of working for government early in their careers," making service opportunities more attractive by showing participants how they can "make a difference."[30] Similarly, the National Commission on Military, National, and Public Service has recommended establishing a fellowship and scholarship center to create and modify fellowships and scholarships rapidly to align with critical skills needed by the federal government.[31]

Although academic internships and fellowships typically carry no commitment to future government employment, they not only build connections to pools of talent but also provide immediate value to DoD through new ideas and research. Vanessa Peña and Chelsea Stokes of IDA have explained:

> Tour of duty appointments can be useful for recruiting top-class talent with specialized skills. The model can be especially alluring to talent with technical expertise who might not otherwise have considered public service. Jennifer Tress, former Director of Talent at 18F, explains: "These [two-

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[29] National Defense Science and Engineering Graduate Fellowship (NDSEG), https://ndseg.sysplus.com/, accessed January 8, 2021.

[30] Partnership for Public Service, "Mobilizing Tech Talent," September 2018, https://ourpublicservice.org/wp-content/uploads/2018/09/Mobilizing_Tech_Talent-2018.09.26.pdf, 27.

[31] National Commission on Military, National, and Public Service, "Inspired to Serve: The Final Report of the National Commission on Military, National, and Public Service, March 2020, https://www.inspire2serve.gov/sites/default/files/final-report/Final%20Report.pdf, 75–76.

> year] terms actually do a good job of saying [to recruited hires], 'We want you here for a focused period of time, and we want you here to disrupt in a respectful way.'" By drawing upon a talent pool from the private sector, tours of duty can help infuse new technologies and innovative practices into agencies.[32]

Peña and Stokes report that fellowship programs have been shown to be effective, but "more could be done to extensively recruit 'middle layer' technical professionals (e.g., senior engineers, senior biologists, senior finance associates—neither early career nor executive leadership) for tour of duty positions."[33]

2. Gaps and Objectives Addressed

This proposal focuses exclusively on civilians and would be directed at building a small cadre of individuals with an elite level of skills. At present, fellowships appear to be used mostly by the research labs and focus heavily on STEM research areas pursued by the laboratories. Expanding this approach beyond the defense laboratories and to digital specialties with more immediate applications would pose challenges for the Department, but could also provide significant rewards.

3. Cost

The major costs of implementing this proposal would be for personnel: tuition, stipends, and the cost of summer employment. We have two independent estimates of the costs associated with these programs. One estimate is from research performed by another IDA team for a 2018 paper.[34] This paper uses the actual cost of running the Science, Mathematics, and Research for Transformation (SMART) program from 2006 through 2016 and includes one entry for each person enrolled in the program with all of the funds each received. For bachelor's students, the average cost per year was $48,000, for master's students it was $53,000, and for doctoral students it was $61,000. The second source of cost data is DoD's establishment of the DCTC Initial Implementation Plan dated August 2020.[35] There is some disagreement among the estimates, but we can say with confidence that the cost per student per year is between $50,000 and $70,000. The DCTC will also have a startup cost of approximately $61 million.

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[32] Vanessa Peña and Chelsea Stokes, *Tour of Duty Hiring in the Federal Government*, IDA Document NS D-10700 (Alexandria, VA: Institute for Defense Analyses, June 2019), 2.

[33] Peña and Stokes, *Tour of Duty Hiring*, 16.

[34] James Belanich et al., *Science, Mathematics, and Research for Transformation (SMART) Outcome Evaluation Report*, IDA Document D-9262 (Alexandria, VA: Institute for Defense Analyses, September 2018).

[35] DoD, *Establishment of Defense Civilian Training Corps: Initial Implementation Plan*, August 2020.

A fellowship program would also entail some administrative costs for managing student participation and summer employment (probably no more than one or two full-time equivalents per military department).

4. Effectiveness

Fellowships have been a highly effective tool for accessing students in the STEM disciplines sought by the laboratories. However, they are likely to be only **moderately effective** as applied to digital fields of study. Because of elevated competition from the private sector arising out of more practical applications of digital expertise, students in these fields are less likely to depend on DoD funding, and less likely to seek follow-on employment at the Department in cases where they do accept such funding.

5. Potential Risks

The IDA team assesses that there is **low risk** associated with this proposal. Graduates in digital specialties are likely to be far more marketable in the private sector than the scientists on whom these programs have focused in the past. With more competing opportunities available, fewer students are likely to seek employment with the Department, and retention rates are likely to be lower for those who do accept employment. However, no major investment is required to implement this proposal. Additionally, risk is reduced because students participating in a fellowship program may bring new ideas and approaches to the Department through their research and summer work even if they are not interested in further employment.

6. Implementation Issues

The expansion of fellowship programs beyond the defense laboratories could lead to implementation issues: graduate students working on academic projects may not find a natural fit in DoD organizations that are not engaged in research. In addition, outreach and recruiting for students in digital fields will be challenging because of competition from the private sector.

7. Synergies with Other Proposals

This proposal could have **major synergies** with other proposals under consideration. Fellowship programs are most effective when accompanied by direct hiring authority, enabling rapid onboarding of successful participants. Coupling this proposal with market-based pay increases for digital career fields might help mitigate the retention problems caused by competition with the private sector for digital talent. Adding civilian rotational career paths might help address graduates' desires for career flexibility and paths to advancement.

D. Recruiting Efforts

The military has an extensive recruiting program in place, although that program is not focused heavily on digital capabilities. Major elements of the military recruiting system include recruiting commands in each military service and the Joint Advertising, Market Research & Studies program in Personnel & Readiness. The Air Force views itself as the technology leader in DoD and heavily emphasizes STEM fields in its civilian recruiting efforts. The Air Force and Marine Corps use the Electronic Data Processing Test to supplement the more general Armed Forces Vocational Aptitude Battery (ASVAB) to test and identify recruits with a high potential for software skills.[36]

Civilian recruiting within DoD has traditionally been much more *ad hoc*, with individual commands and organizations conducting their own recruiting efforts. Civilian recruiters are generally scattered through the military services, defense agencies, and field activities, sometimes leading to internal DoD competition at job fairs and affinity events. Although a few central offices (such as the Talent Acquisition Division of the Air Force's Personnel Center) provide specialized recruiting assistance, these offices appear to rely heavily on local hiring managers who supplement, rather than replace, their work.

E. Proposal 7: STEM Civilian Recruiting Offices

1. Description

The NSCAI has proposed enhancing civilian recruiting efforts by standing up centralized, digital talent recruiting offices in DoD and other national security agencies. The NSCAI explained:

> Recruiting offices would monitor their agencies' need for specific types of digital talent. The offices would be empowered to recruit technologists virtually by attending conferences, career fairs, recruiting on college campuses, and offering scholarships, recruiting bonuses, referral bonuses, non-traditional recruiting techniques such as prize competitions, and other recruiting mechanisms… This would help scale digital talent recruitment by creating a central, empowered organization that focuses on a specific mission; concentrates expertise and funds; would help experts move in and out of government positions throughout their career; and can develop relationships with universities and private sector companies.[37]

Consistent with the organization of the DoD civilian workforce, it might be more appropriate to establish separate digital talent recruiting offices in each military department

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[36] This test is described in "Electronic Data Processing Test (EDPT)," https://www.thebalancecareers.com/, accessed January 8, 2021.

[37] NSCAI, *Interim Report and Third Quarter Recommendations*, October 2020, https://drive.google.com /file/d/1jg9YlNagGI_0rid-HXY-fvJOAejlFIiy/view, 97.

and for the Fourth Estate. These offices could conduct tailored outreach, recruiting, and hiring in coordination with subordinate commands and entities. These offices would also work with HCI and other career-field managers to match talent to organizations and to promote the efficient use of hiring authorities.

2. Gaps and Objectives Addressed

This proposal would be directed at recruiting civilian talent. A centralized recruiting office could assist hiring managers in accessing talent across the full range of digital skills. Depending on how this office is structured, it could focus on high-end talent, mid-career talent, or both.

3. Cost

The most important cost factor for a new recruiting office would be personnel costs. The NSCAI assessed that an office of 20 personnel would be needed to recruit both early career and experienced professionals. The IDA team believes that an office of this size would need to leverage recruiting resources in individual commands and agencies; a recruiting office that conducts extensive, centralized recruiting and hiring would need to be considerably larger. In addition to personnel costs, a central recruiting office might require a budget for marketing activities, to establish an online presence, and to set up job fairs and similar events.

For modeling costs, we postulated a DoD civilian recruiting office led by a Senior Executive Service (SES) with a total staff of 20 government civilians. The personnel costs for such an office would be approximately $3 million. Allowing for marketing activities, travel, contracting support, facilities, and other expenses, we estimate the rough order of magnitude costs to be $5.5 million. If two such offices were established—one for the eastern United States and one for the western United States—the combined cost would total $11 million.

4. Effectiveness

A centralized organization at the OSD level, as recommended by the NSCAI, would be questionably effective. The issue is that OUSD(P&R), to which the office would report, does not have operational responsibilities. Hiring is not only handled by the military Services and defense agencies, it is also handled on a highly distributed basis by individual commands and organizations within those larger entities. A central recruiting group at the OSD level—or even at the Service level—would have difficulty understanding the specific needs of individual commands and organizations. In addition, such a group would have difficulty persuading the hiring managers in those commands and organizations to hire personnel who have been selected for them by a central agency.

However, a centralized organization at the military department level would be **moderately effective** if it focused on providing specialized recruiting expertise and assistance rather than on trying to supplant the role of recruiters at the command level.

5. Potential Risks

The IDA team assesses that this proposal could be implemented with **moderate risk**. A central recruiting office for digital talent is likely to be perceived by local hiring managers and recruiting offices as an extra layer of bureaucracy that does not add value. If the central office tries to impose its own hiring decisions on local commands and organizations, it may be perceived as complicating the hiring process rather than making it easier to access needed talent. However, if the office focuses on providing value to local commands and organization, it could raise the professionalism of digital recruiting efforts across the Department.

6. Implementation Issues

The most troublesome implementation issue for this proposal would be the relationship between the central recruiting office and local hiring authorities. Because DoD civilian hiring is handled locally, the effectiveness of a central recruiting office would be entirely dependent on the relationship between the central office and local hiring authorities. This approach can succeed only by building a positive relationship in which the central office is perceived as adding value rather than bureaucracy.

7. Synergies with Other Proposals

A centralized hiring office could work with cohort hiring by assessing needs across organizations and identifying pools of available talent for placement into training programs and billets as they become available. This approach is most likely to work if the central office brings a separate funding source for initial hires under the cohort program and holds the billets centrally. This approach could cause participants to be perceived by local commands as a "free resource" rather than as a tax on local resources.

F. Proposal 8: Digital Force Recruiting Units for Uniformed Service

1. Description

The Department might also consider developing a specialized recruiting capability for uniformed personnel. At present, the military Services use the same recruiting force to access digital talent and to build combat specialties. For example, the Army has built references to high-tech positions into its general marketing approach, but has not developed a separate line of advertising.

The Army Medical Recruiting Brigade within the U.S. Army Recruiting Command provides a model for specialized recruiting directed at accessing highly skilled specialists. The military Services could consider a similar model for acquiring digital talent.

2. Gaps and Objectives Addressed

This proposal would address the recruiting of entry-level skills in the military workforce. The particular focus would be on digital skills such as software development.

3. Cost

The Army has a special recruiting unit for medical doctors that employs 15 officers and 62 enlisted personnel. FCoM says the cost of these personnel is $12 million per year. Each year, the office brings in about 5,000 healthcare specialists and 600 medical officers, so DoD spends about $2,000 to recruit the average new soldier. We estimate that the cost would be the same for bringing new digital engineers into the military. If the military wants to change the number of recruits, they could add or subtract recruiters.

4. Effectiveness

The IDA team anticipates that this proposal would be **moderately effective**. The Services have had success with special recruiting units for medical professionals and special operations forces. The IDA team believes that similarly focused recruiting units could be equally helpful in identifying and accessing digital talent. The Air Force, which views itself as the technology service, has developed a digital aptitude test that it uses to supplement the more general ASVAB test to identify recruits with a high potential for software skills. Special digital recruiting units in the other Services might help bring similar testing and other focused recruiting efforts to those Services as well.

5. Potential Risks

The IDA team assesses that this proposal would carry **high risk**. The military Services have traditionally organized recruiting efforts geographically to reach as many potential recruits as possible. The new digital recruiting units would disrupt the established organization of military recruiting offices and could find it challenging to establish a similar geographic reach with a much smaller force.

6. Implementation Issues

The Services currently conduct most recruiting geographically with recruiting teams dispersed to local communities. A digital recruiting unit is not likely to be sufficiently staffed to cover the full range of geographic options. This approach leads to questions about whether digital recruiters would be dispersed across the country, concentrated in locations

with abundant digital talent, or dependent on virtual recruiting methods rather than physical presence.

7. Synergies with Other Proposals

This proposal would work well with a revised ASVAB that adds a new category for computational thinking similar to the digital aptitude test currently used by the Air Force. This proposal could also work well with digital boot camps by helping the Services access a population that would most benefit from such training.

G. Hiring Activities

The federal civilian hiring process is famously bureaucratic and time-consuming. However, streamlined direct-hiring authority is now available for the entire DoD digital workforce.[38] As noted previously, similar direct hiring authorities have now become the most common mode of hiring in the acquisition workforce.

The uniformed military "hiring" process is firmly established, as described next:

- For officers—accession through the ROTC, Office Candidate School, and military service academies
- For enlisted personnel—testing through the ASVAB and accession through the U.S. Military Entrance Processing Command

Few modifications to the military accession process have been proposed. However, the NSCAI for 2020 recommended adding a section on computational thinking to the ASVAB that could help military recruiters identify potential digital talent.

Proposals for improving civilian hiring range from steps to optimize existing hiring authorities to the establishment of new civilian hiring pipelines. These efforts could be accomplished through cohort hiring, the increased use of SMEs to evaluate applications for employment, and the use of rigorous technical evaluations (including reviews of students' digital work repositories (also called ePortfolios).

H. Proposal 9: Cohort hiring

1. Description

Cohort hiring is an approach under which the Department brings in large groups of entry-level new hires for a specific career track and places them into a coordinated program that incorporates blocks of training and education along with rotational, career-building

[38] Title 10, United States Code, Section 9905, Direct hire authority for certain personnel of the Department of Defense, as amended by the FY 2020 NDAA.

assignments. This approach contrasts with traditional hiring practices in which new employees are hired individually as positions become available.

The National Academy of Public Administration (NAPA) explained this approach as follows:

> Pooled hiring streamlines talent accession by hiring many new employees (especially at the entry level) to fill multiple vacancies at once. This permits maintaining a "pool" of qualified, screened talent for a line of work. This approach features:
>
> - a coordinated outreach by talent managers to talent sources (such as universities or training programs);
> - program managers defining the knowledge and skills necessary when choosing among candidates to be in the pool; and
> - streamlined procedures for managers to select from among candidates already determined to be "highly qualified."[39]

Several DoD components currently run cohort hiring programs for narrow segments of the workforce. These include the Air Force Palace Acquire program, which focuses heavily on STEM career fields; Navy internship programs for the acquisition workforce and for personnel specialists; the Defense Contract Audit Agency program for new auditors; and programs for the acquisition workforce in the Defense Logistics Agency and the Missile Defense Agency.

2. Gaps and Objectives Addressed

This proposal would address new hires in the civilian workforce. Existing cohort hiring programs could be extended, or new programs could be established, to address entry-level digital skills.

3. Cost

Implementing a cohort hiring program would require reallocating funds, but the net effect of the investment should yield a modest savings. Cohort hiring allows multiple hires to be brought onboard by a single hiring panel with a single set of interviews, rather than requiring a separate panel and a separate set of interviews for each position. Centralizing hiring and training is more efficient than having several individual offices conduct hiring separately. (Unfortunately, we found no data on civilian hiring costs, so it is not possible to estimate the baseline or the savings.)

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[39] NAPA, "No Time to Wait, Part II: Building a Public Service for the 21st Century," September 2018, https://www.napawash.org/uploads/Academy_Studies/NTTW2_09192018_WebVersion.pdf, 20.

Usually, new hires under a cohort hiring approach spend most of their time on work similar to that performed by other new hires in their organizations, so there is no net cost to the Department. However, best-in-class cohort hiring programs put new recruits through common training and rotational programs to build foundational knowledge and expertise, group cohesion, and commitment to the mission.

For this estimate, the IDA team assumes a three-month training and rotational program for cohort hires, in addition to any other training that other new hires receive. We postulate that the cost of this would equal the costs of DoD "boot camps" discussed later under Proposal 14. Thus, the estimated cost would range between $18,000 and $36,000 for each new government employee brought in through cohort hiring. As described earlier, the cost of new training and rotations would be partially offset by administrative savings from a more efficient hiring process.

4. Effectiveness

The IDA team assesses that this proposal is likely to be **highly effective** when properly applied to new positions for which there is sufficient volume or turnover to support the creation of a requirement before vacancies arise. In addition, this proposal will likely succeed when it is necessary to justify common training and rotational programs as a part of the onboarding process. This proposal is not likely to succeed for highly specialized or advanced areas where each position requires unique skills and qualifications.

5. Potential Risks

The IDA team assesses that this proposal carries a **moderate risk**. The most significant risk is that hiring managers who usually choose among candidates may resist accepting new hires who are centrally selected. Such resistance is likely to be lowest with entry-level positions and to increase as levels of skill and responsibility increase. Holding funding and billets at a central level and involving local hiring managers in the selection process can also reduce the risk of pushback.

6. Implementation Issues

Cohort hiring works best with a central funding source. Without such funding, hiring managers will perceive that they are being forced to spend their money on a candidate they did not choose.

This approach would be further enhanced by development programs that build individual qualifications and a sense of community over time. Cohesive efforts to train and mentor participants may enhance recruiting and retention by fostering a sense of mission and belonging.

7. Synergies with Other Proposals

Cohort hiring has significant synergies with other proposals under consideration. It would work well with requirements analysis and workforce tracking and metrics, enabling the Department to identify workforce needs that can be met on a cohort hiring basis. It is likely to be most effective when coupled with civilian rotational career paths. Highly qualified individuals are likely to participate if they perceive that they are entering a program with a strong mission and potential for growth and advancement.

I. Proposal 10: Rotational Cadres of Digital Experts

1. Description

This proposal would establish a cadre of digital experts serving short-term rotational or episodic tours of duty to address specific challenges within the Department. For example, the DIB has recommended establishing dedicated software development units in each military Service to develop and deploy software to the field.[40] NAPA explained this approach as follows:

> [T]he government could create cadres of experts hired for high-priority needs on a relatively short-term basis (for 3 to 5 years, with the possibility of annual renewal). We expect that members of these cadres would generally eschew 30-year federal careers and may often rotate out of the Federal Government into state and local governments or into the private or nonprofit sectors. The Federal Government should then make it possible for members of these cadres to rotate back into federal service, at a higher rank or level of pay than the one they left (if warranted). Encouraging the movement of talent across boundaries would only enhance the capacity of all those who collectively are responsible for the quality of the Federal Government's work.[41]

At the high end, a digital cadre could be modeled on the JASON defense advisory panel, which has produced cutting-edge reports on defense science and technology issues for several decades.[42] At the mid-tier level, a cadre approach might be similar to the Defense Digital Service.

2. Gaps and Objectives Addressed

This proposal would add mid- to high-level expertise to the defense civilian workforce. It could be applied to all digital fields, including software development, DE, AI, and machine learning.

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[40] DIB, *Software Is Never Done*, 40–41.

[41] NAPA, "No Time to Wait, Part II," 20.

[42] For an overview of the JASON organization and mission, see https://fas.org/irp/agency/dod/jason/.

3. Cost

The main cost driver for a cadre of digital experts would be personnel costs. To attract the kind of expertise DoD needs, it should expect to pay participants at a rate higher than typical civil service salaries. This approach could be implemented using the pay flexibility available for Highly Qualified Experts, which generally allows pay ranging from GS15, step 1 to Executive Schedule IV salaries (roughly $110,000 to $170,000) plus locality pay. Alternatively, the Department could seek special authorization from the Congress for higher levels of pay.

A digital cadre would also require a management structure to handle administrative and personnel matters. Although some of these issues could be addressed by an existing defense agency acting as an Executive Agent, the Department should anticipate hiring at least some administrative personnel.

4. Effectiveness

The IDA team assesses digital cadres as a **highly effective** method of acquiring top-tier talent**.** DoD experiments include the Defense Digital Service, which has brought working-level expertise from Silicon Valley into the Department. In addition, the Air Force's Kessel Run and other software factories have successfully rotated through military and civilian personnel, Intergovernmental Personnel Act (IPA) mechanisms, and contractors with digital expertise. DARPA could also be considered a model for a rotational cadre, with its practice of onboarding highly credentialed experts to serve as program managers for specific projects. All of these experiments have enabled the Department to access and capitalize on highly qualified talent that would likely not otherwise be available among military or civilian employees.

5. Potential Risks

The IDA team assesses a relatively **low risk** for this proposal. Rotational programs depend on being refreshed by a constant stream of talent to replace departing personnel. At the Defense Digital Service, for example, even the director commits to sign on only for a limited period of time. These programs do not place a high value on career building and are unlikely to create a stable cadre of federal expertise. As a result, individuals who are interested in building expertise and serving longer periods may find their careers neglected. For example, the Air Force has had difficulty identifying career tracks for military personnel who rotate through Kessel Run. However, these programs have been extremely successful in enabling the Department to access top talent on a temporary basis.

6. Implementation Issues

Any new rotational cadre will require establishing a new organization with an appropriate number of billets. Establishing a new organization is a time-consuming

endeavor in DoD. Moreover, funding and billets are likely to threaten existing organizations, meaning top-level support will be required for any expansion.

Additionally, a rotational cadre relies on a constant flow of talent in lieu of a stable body of personnel. Therefore, it is likely to be uniquely dependent on skilled and innovative leadership to remain at the cutting edge, where it can continue to attract needed talent. This requirement may make it difficult to scale up rotational models beyond a certain point.

7. Synergies with Other Proposals

Rotational cadres would be expected to have major synergies with other proposals for accessing digital talent. This approach would be most effective when combined with market-based pay incentives to bring in highly qualified experts. Rotational cadres of experts might work well with civilian recruiting offices designed to provide outreach into the digital community and identify potential new hires. The risk is that a formal recruiting office could become bureaucratic and distanced from the cadre itself, making it less effective than informal recruiting networks.

J. Blended Proposals

DoD could build a pipeline of new talent by merging multiple phases of outreach, recruiting, and hiring in a single program. DoD has a number of programs under which it offers to pay for a recruit's education and/or provide temporary employment in exchange for a binding service commitment. This approach combines elements of outreach and recruiting (building ties to the academic community with a propensity for defense civilian service) with elements of hiring (providing long-term employment for those who successfully complete the program).

The Department could consider a number of different blended proposals, including the expanded use of existing scholarship-for-service programs, the development of a civilian equivalent of the ROTC, and even the establishment of a new civilian digital service academy.

K. Proposal 11: Expanded SMART Scholarships and Cyber: Scholarships for Service

1. Description

Existing scholarship-for-service programs, including the SMART program and the Cyber: Scholarships for Service (C:SFS) program, provide scholarships, stipends, and summer employment to promising students in exchange for a service commitment. For each year of tuition paid for by the program, the student incurs a one-year service commitment. This proposal would expand these existing programs to address the full range

of the Department's need for cutting-edge digital skills. The NSCAI report concludes that such an expansion could increase the pool of digital talent available in government service:

> C:SFS boasts a 92-95% placement rate, has over 70 active institutions participating, and has placed approximately 3,600 graduates in over 140 government institutions since 2001. SMART has a similarly successful record, having awarded 1,262 scholarships from 2016 to 2019. With more funding, scholarship-for-service programs could quickly increase the digital talent in government service.[43]

The Cyberspace Solarium Commission has endorsed a similar approach.[44]

2. Gaps and Objectives Addressed

This proposal would address both recruiting and training/education for mid- to high-end digital skills in the civilian workforce. It could be rapidly adapted to address additional requirements for critical skills as they emerge.

3. Cost

The costs of this program would be comparable to the costs described earlier for fellowships with stipends in Section 4.C. There we noted that a review of the SMART program found that for bachelor's students, the average cost per year was $48,000 per year, for master's students it was $53,000 per year, and for doctoral students it was $61,000 per year. This proposal is, in essence, an extension and expansion of the existing SMART program. Because the program structure is already in place, there should be no start-up cost and only minimal, incremental administrative cost.

4. Effectiveness

The IDA team assesses that this proposal would be **highly effective**. An IDA review found that the SMART program attracted students who would not otherwise have considered DoD employment, drawing higher quality candidates and improving the performance of the DoD science and technology workforce.[45] Interviews with DoD hiring managers and personnel experts confirm that the program is viewed as an essential source of highly qualified STEM professionals.

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[43] NSCAI, "Second Quarter Recommendations," July 2020, https://drive.google.com/file/d/1hgiA38FcyFcVQOJhsycz0Ami4Q6VLVEU/view, 42.

[44] Cyberspace Solarium Commission, "Final Report," March 2020, https://drive.google.com/file/d/1ryMCIL_dZ30QyjFqFkkf10MxIXJGT4yv/view, 44.

[45] James Belanich and Asha Balakrishnan, *SMART Program Bolsters Quality of STEM Talent in Defense Civilian Workforce*, IDA Document NS D-10521 (Alexandria, VA: Institute for Defense Analyses, May 2019).

5. Potential Risks

The IDA team assesses that this proposal carries **low risk**. The biggest concern is that the Department has often had difficulty retaining SMART scholars after the completion of their service obligations. However, SMART scholars bring skills for which there is significant private sector competition. Interviews with DoD hiring managers indicate that the Department benefits from these skills even when personnel changes rapidly.

6. Implementation Issues

The biggest implementation issue for this proposal is turnover among graduates. Frustration with salaries, work culture, and work experience and placement in jobs far from home lead to low retention rates past the completion of service obligations. The IDA team found that these issues could be mitigated by (1) building more flexibility regarding scholar placement between scholar and facility, perhaps allowing scholars to rotate among commands or Services; (2) monitoring starting salaries to ensure that SMART scholars are paid commensurate with their peers; and (3) ensuring that sponsoring facilities provide scholars effective mentorship, training, and work experiences commensurate with their skills and interests.[46]

In addition, the SMART program is a scholarship-for-service program that carries a service obligation—generally 1 year of service for each year of education received. Although the service obligation guarantees some return on the Department's investment, there are indications that the captive nature of SMART graduates may cause some managers to undercompensate or otherwise underappreciate graduates, leading to friction and early departures.

7. Synergies with Other Proposals

This proposal could be highly effective if coupled with proposals for market-based pay increases for digital career fields. Paying SMART scholars at competitive rates could help reduce retention problems for scholars who complete their service obligations.

L. Proposal 12: Defense Civilian Training Corps

1. Description

The NDAA for FY 2020 included a provision requiring the Secretary of Defense to establish the DCTC, modeled on the ROTC, "[f]or the purposes of preparing selected students for public service in Department of Defense occupations relating to acquisition, science, engineering, or other civilian occupations determined by the Secretary of Defense,

[46] Belanich and Balakrishnan, *SMART Program Bolsters Quality.*

and to target critical skill gaps in the Department of Defense." [47] In August 2020, the Department published an implementation plan, which calls for deploying the first DCTC unit by August 2021.[48]

The NSCAI has called for the establishment of a National Reserve Digital Corps (NRDC) of civilian reservists. The NSCAI envisions that the NRDC would be fed by a scholarship program similar to the ROTC, but with rules and service requirements that differ from the recently enacted legislation.[49] Nonetheless, the legislation and the NSCAI recommendation share a similar vision of a civilian scholarship program built around ROTC-like units that would enhance not only digital expertise, but also unit cohesion and alignment with DoD's mission.

2. Gaps and Objectives Addressed

This proposal would address the same gaps and objectives as the proposal for expanded scholarship-for-service programs. It would address both recruiting and training/education for mid- to high-end digital skills in the civilian workforce. In addition, this proposal could be adapted rapidly to address additional requirements for critical skills as they emerge.

3. Cost

Cost factors for this proposal would be similar to cost factors for expanded scholarship-for-service programs. The primary costs would be the cost of tuition, stipends, and summer employment. As discussed earlier in section 4.C, these costs average about $48,000 per year for each undergraduate student.

In addition to these direct payments to students, the DCTC implementation plan estimates startup costs of $61 million. Beyond startup, the IDA team assesses that a digital service corps would have higher administrative costs than existing scholarship-for-service programs because of the need to establish units on college and university campuses, with the related requirements for reaching agreements with academic institutions, accessing facilities, and conducting unit training.

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47 Title 10, United States Code, Chapter 113, Secretary of Defense, https://www.govinfo.gov/app/details/USCODE-2011-title10/USCODE-2011-title10-subtitleA-partI-chap2-sec113/context.

48 OUSD(A&S) and Office of the Under Secretary of Defense for Personnel and Readiness (OUSD(P&R), "Establishment of Defense Civilian Training Corps: Initial Implementation Plan," August 2020, https://www.hci.mil/docs/DCTC_InitialImplementationPlan_Aug2020.pdf.

49 NSCAI, "Second Quarter Recommendations," https://www.nscai.gov, 37–39.

4. Effectiveness

The IDA team assesses that this proposal is likely to be **moderately effective**. The use of an ROTC-like approach to civilian education remains untested. The ROTC has had decades to build its brand and is directed at students who have a propensity to military service. Although scholarship-for-service programs have been highly effective in attracting high-quality candidates and drawing them into the DoD workforce, it remains unknown whether civilian students in STEM fields will be amenable to the prospect of training in units for DoD service.

5. Potential Risks

The IDA team assesses that this proposal carries **moderate risk**. The success of the program likely depends on factors like branding, quality of work experience, and proportionality of service commitment. In addition, the proposed service commitment of two years for every year of scholarship (double the service requirement for the SMART program) may prove a disincentive to enrollment. Establishing a new DCTC will require a significant investment of time and resources, so a failed experiment would be costlier than just another scholarship or fellowship program.

6. Implementation Issues

The major implementation issue for DCTC will be the design and implementation of DCTC-unique program content. The DoD implementation report states that

> DCTC will have an undergraduate curriculum centered on public service in DoD and designed to align the student's academic courses of study with a DCTC curriculum providing opportunity for exposure to emerging technologies and opportunity to apply STEM knowledge to current technical challenges facing the DoD.[50]

DCTC scholars will be organized into units to receive defense-unique training.

An additional implementation issue will be recruiting students to participate. It is not clear that the type of high-end STEM scholars that the Department seeks will be attracted by the prospect of unit training and a curriculum "centered on public service" and DoD-unique challenges. Recruiting may be further impeded by a service requirement that is double the service requirement applied under the SMART program.

If the Congress and DoD decide to implement the NSCAI proposal for a separate ROTC-like National Reserve Corps Digital Scholarship Program, potential branding problems and confusion between the two programs would likely lead to further implementation issues.

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[50] OUSD(A&S) and OUSD(P&R), "DCTC Implementation Plan."

7. Synergies with Other Proposals

This proposal would have significant synergies with new civilian career fields and market-based pay approaches. Providing focused career proposals and paying graduating scholars at competitive rates could help reduce retention problems for those who complete their service obligations.

M. Proposal 13: Digital Service Academy for Civilians

1. Description

This proposal would establish a new digital service academy for civilians, modeled on the military service academies. The NSCAI, which recommends such a new academy, explains the approach as follows:

> The United States needs a new academy to train future public servants in digital skills. …The USDSA [U.S. Digital Service Academy] should be modeled off of the five U.S. military service academies but should produce trained government civilians. …It would be a degree granting institution focused on producing leaders for the United States Government. USDSA students, like military service academy students, would not pay for tuition, or room and board, and would have a post-graduation service obligation. …The USDSA would differ in significant ways. First and foremost, USDSA students would enter the institution to become civil servants. They would know that their education would be repaid in the form of a 5-year obligation to serve in government, which would begin upon graduation when they become a civil servant at a GS-7 level. …USDSA students would also have a more STEM-focused education. While the core curriculum would ensure broad exposure to different fields, students would have a highly technical education.[51]

2. Gaps and Objectives Addressed

This proposal would address the same gaps and objectives as the proposal for expanded scholarship-for-service programs. In addition, this proposal would address recruiting, training, and education for mid- to high-end digital skills in the civilian workforce. It could also be adapted to address additional requirements for critical skills as they emerge.

3. Cost

This proposal is for a four-year, accredited, government-run university specifically for digital engineers. As an example of what this might cost, we turned to the Uniformed Services University of the Health Sciences (USUHS), a health science university of the

[51] NSCAI, "Second Quarter Recommendations," 43–44.

federal government based in Bethesda, Maryland. Established in 1972, USUHS is similar to the federal service academies in that all students are members of the uniformed services and receive free education in exchange for a service commitment after graduation.

A paper by an IDA research team[52] found that the cost per student of a USUHS graduate is $268,000 per year, for a four-year total cost of $1.07 million (budget year [BY] 2020). The per-student cost of educating a USUHS graduate includes both student compensation and instructional costs, as shown in Table 7. USUHS students receive the full active-duty pay and benefits of an O-1. They also receive an extra 700 hours of curriculum that include military-specific field exercises, which are included in instructional costs. In addition, a November 1974 Environmental Impact Statement prepared by the Department of the Navy estimated the total construction costs for USUHS to be $190 million (then-year [TY] 1974) or $800 million (BY 2020).

Table 7. Operating Costs of the USUHS

Cost Category	BY 2020
Annual Student Compensation	$96,366.66
Annual Instruction	$171,553.84
Annual Total	$267,920.50
4-Year Cost per Student	$1,071,681.99

4. Effectiveness

The IDA team assesses that this proposal would be **questionably effective**. The success of a civilian digital service academy would depend largely on the Department's ability to stand up a high-quality academic institution that can compete with existing colleges and universities for faculty and students. Although the USDSA would be a new institution with no proven track record, existing academic institutions have established programs with expertise and reputations built over decades.

The military academies (including the Air Force Academy, which was established in 1954) compete favorably with private institutions. However, the military academies offer a distinct occupation with unique training, an established sense of community and mission, and a well-defined path to leadership positions both in military service and after. It is not clear that the offer of a career beginning as a GS-7 in the federal civil service will prove as much of an attraction, particularly when the government competes against private sector entities that routinely offer starting salaries of $100,000 or more to highly qualified graduates in high-demand digital fields.

[52] Sarah John et al., *Analysis of DoD Accession Alternatives for Military Physicians: Readiness Value and Cost*, IDA Paper P-10815 (Alexandria, VA: Institute for Defense Analyses, November 2019).

5. Potential Risks

The IDA team assesses that this proposal carries a **high risk**. One significant risk is that the Department will be unable to attract highly qualified faculty and students. Establishing a digital service academy will require significant up-front investment and overhead costs, so a failed experiment would be far costlier than just another scholarship or fellowship program.

6. Implementation Issues

The major implementation issues for this proposal are lead time and up-front costs. Standing up a new university is a time-consuming and difficult endeavor that requires extensive planning, brick-and-mortar construction, establishment and staffing of a legal and administrative framework, hiring of qualified faculty, and methods for attracting students.

Other proposals carry lower risks because they would enable DoD to bypass these requirements by partnering with existing academic institutions and drawing on their established expertise. For example, the Army recently partnered with Carnegie Mellon University to train military and civilian personnel in AI. It will be difficult for the Department to replicate a similar level of expertise in a newly built academic institution dedicated solely to producing civil servants.

7. Synergies with Other Proposals

The civilian digital service academy would be most attractive if it were coupled with new digital career fields, rotational civilian career paths, and increased (market-based) pay to make civilian employment more attractive to highly qualified candidates.

5. Education and Training

DoD will draw heavily on degrees and coursework from established military and civilian programs for the needed education and training of the DE workforce. However, a number of proposals for DoD-sponsored education and training programs are needed to complement existing programs. These proposals are aimed primarily at bolstering DE skills within established DoD occupations.

A. Proposal 14: Digital Boot Camps for Upskilling Military and Civilian Employees

1. Description

In the education world, the term "boot camp" refers to an immersive, medium-term to full-time curriculum designed to produce marketable skills in a specific competence area. Compared to traditional curricula at community colleges or universities, boot camps are both more intensive and less broad in their educational goals. The target competencies are similar to (but less broad than) those in an apprenticeship or vocational certificate program. In addition, they are more applied and less grounded in theory than coursework in a four-year postsecondary institution. A typical boot camp program lasts 6 to 10 weeks, training a cohort of 10 to 30 students in interactive teams, with the intent of instilling a useful set of entry-level skills at the end of that period. To date, the boot camp approach has most often been used to produce software developers, but the model can in principle be applied to any competence area of comparable scope.

Several advisory panels, including the DIB, have proposed[53] that DoD could use the boot camp model to introduce specific digital skills into the DoD workforce.

2. Gaps and Objectives Addressed

Boot camps could potentially be applied to any or all of the DE competence areas identified in Chapter 1. Boot camps are most often used to introduce entry-level talent to the workforce, especially in the field of software development, but it would also be possible to use a boot camp model to retrain or supplement the skills of existing personnel. Boot camps could address gaps in the supply of software developers (and other specialties) within DoD, and help to mitigate the mismatch between DoD capability needs and

[53] DIB, *Software Is Never Done.*

academic curricula in computer science and information systems. Boot camps could also be used to enhance both civilian and uniformed workforces. Depending on the target workforce and skill sets, boot camps could have primary effects on either recruiting and hiring or on education and training. In addition, boot camps could be used in a secondary role for competency and certification.

3. Cost

The costs of digital boot camps are influenced by some choices regarding the implementation approach. Three of the significant parameters include:

1. Leveraging existing commercial boot camps versus creating DoD-unique programs
2. Targeting the correct level of instruction, which could range from entry-level courses to more complex offerings for retraining and upskilling existing personnel
3. Determining what size cohort of graduates to strive for—broad dissemination of entry-level skills in several people or the development of a small number of experts in particular areas

Costs were estimated for a hypothetical commercial boot camp program and a customized DoD digital boot camp course. For each variant, the assumptions about course length, instructional content and complexity, and target number of graduates per year were aligned to ensure a fair comparison of analogous efforts. Depending upon the variant, the model incorporates course fees or development costs, instruction and facilities cost, and compensation and support for participating students.[54]

The largest cost drivers are compensation for student time travel, and lodging. At the more advanced end of the curriculum spectrum, course fees for commercially available courses also have weight in the total. It is notable that the estimates are sensitive to the location assumed for the training site. Because most commercially available courses are offered in major metropolitan areas, and a DoD custom course is assumed to be delivered in an existing DoD facility in a lower cost market, the cost of supporting a student onsite for commercial courses exceeds the savings realized by leveraging the existing courses.

[54] The IDA team modeled the cost of a boot camp program by estimating development cost for a notional 6- to 8-week immersive onsite course customized for DoD. We combined this with the participant and instructor salary and travel costs, and the computer lab/classroom facility operating costs for one year of operation. The course envisioned would provide full-time, intensive instruction focused on imparting digital skill sets of high value to DoD in a relatively short period and is modeled on "coding boot camp" courses offered by several education providers. Successful completion rates are used to adjust for the number of students expected to withdraw from the course prior to completion. These rates are taken from reports from schools offering courses upon which the envisioned course is patterned and published by the Council on Integrity in Results Reporting (CIRR).

The resulting per graduate cost of the boot camp option is estimated to range from approximately $19,000 for a custom DoD introductory curriculum to $55,000 for an intensive, highly advanced curriculum offered commercially.

4. Effectiveness

Studies of boot camp programs to date[55] find them to be **moderately effective**, depending on the details of the program and the degree of alignment between the curriculum and the needs of the hiring organization.

5. Potential Risks

There are **moderate risks** associated with widespread use of boot camp programs to onboard talent. Boot camp training typically focuses strongly on practical skills ("knowing how"), with less emphasis on context ("knowing what") and little on theory ("knowing why"). This focus makes boot camps most effective for specialties where a limited toolkit can be applied repeatedly—website development, database implementation, cybersecurity, basic data analytics, and so on. If commercial sector boot camps are used, the marketable skills emphasized might not align with the skills most useful within DoD. This situation would not only decrease value to DoD, but could simultaneously lead to retention issues by making boot camp graduates more marketable outside the Department.

6. Implementation Issues

For skill sets that are valued in the commercial workforce, DoD can leverage existing boot camp programs. For defense-specific skill sets, sponsoring organizations would need to establish their own boot camp programs. Prototype DoD-specific programs already exist, such as the Air Force "Advanced Course in Engineering." which provides a boot camp for cybersecurity professionals. Few current DAU courses are sufficiently intensive or hands-on to qualify as boot camps, but this could be changed. Using existing DAU infrastructure could mitigate implementation costs of new boot camp programs.

The other major implementation issue for boot camps is placement of graduates. It is not enough for DoD to inject skills into the workforce; it must also place skilled individuals into positions where they can apply those skills to further DoD's mission. Unless the Department knows what type of work it wants graduates to do, *and has slots/billets to place them into*, the training will not be effective. One way to address this would be to have individual commands nominate or recruit individuals to attend boot camps based on

[55] For example, see Ilenia Fronza et al., "Evaluating the Effectiveness of a Coding Camp through the Analysis of a Follow-Up Project," *Proceedings of the 21st Annual Conference on Information Technology Education*, October 2020, 248–253; Leslie J. Waguespack et al., *Triangulating Coding Boot Camps in IS Education: Bootleg Education or Disruptive Innovation?*, *Information Systems Education Journal* Volume 16, no. 6, December 2018; and Logan M. Prough, "Education Theories Applied to a Cybersecurity Boot Camp," Master's Thesis, Kansas State University, 2018.

established needs, with specific positions held open for graduates to fill after they complete the training.

7. Synergies with Other Proposals

There are **significant synergies** between the use of boot camps and other DE workforce enhancement proposals. Because many boot camp programs assume no prior education or training in their specific fields, they are uniquely suited to applicants from disadvantaged backgrounds. For this reason, there are synergies with recruiting and outreach efforts aimed at those communities.

As noted by the DIB, boot camp programs:

> must be married with support for the individuals to stay and grow within their chosen field. DoD could leverage several possible human capital pathways:
>
> - Core military occupational series (MOS) and civilian occupational series for software development that include subcategories to address the various duties found in modern software development (e.g., developers/engineers, product owners, and designers).
> - [Credentials for DE-related expertise/training that would indicate readiness to serve in various roles][56]

In addition, boot camp programs are inherently cohort-based and thus could be productively combined with cohort hiring initiatives. As a result, important synergies exist between boot camp programs and more general recruiting, career tracking, talent management, and retention efforts.

B. Proposal 15: DoD Reimbursed Online Coursework

1. Description

The 21st century has seen a proliferation of online training and education opportunities in a wide variety of fields. Commercial online training is now available for a wide variety of DE skills, including software development, data science, cybersecurity, AI, and machine learning. Some parts of the Department are already taking advantage of commercial online training vehicles such as Coursera.

[56] DIB, *Software Is Never Done*, 13.

It has been proposed[57] that the DoD workforce could more systematically take advantage of available online training and education resources to enhance high-priority digital skills in the DoD workforce.

2. Gaps and Objectives Addressed

Online self-improvement resources (both formal academic courses and less formal training opportunities) are available on a wide range of topics relevant to defense DE and at various levels of presentation, from introductory to graduate-level instruction. These resources are potentially available to both military and civilian personnel across all skill sets and throughout career arcs.

3. Cost

External online resources range from free secondary education (e.g., Khan Academy) through accelerated university degrees. Free offerings typically consist of about two hours of instruction, while advanced certification programs can offer up to 24 weeks of 16 hours of instruction per week.

The IDA team estimated the costs of a program for reimbursed online coursework based upon 600 course completions in a year. Because attrition rates for fully remote instruction are high, successful completion rates reported by industry are used to adjust for the number of students who can be expected to withdraw from the course prior to completion.[58]

The bulk of the costs are course fees. The resulting per graduate cost for the first year of the commercially available, online certification option are estimated to range from less than $100 to a high of $8,700.

We can compare these estimates to the experience of the Defense Acquisition Workforce. In 2019, DoD spent an average of $1,521 on education and training for each member of the Acquisition Workforce. This figure includes a wide range of training activities, and no doubt the level of expenditures varied significantly across individuals depending on their career situation.

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[57] For examples, see *NSCAI First Quarter Recommendations*, March 2020, 31.

[58] Estimates of the cost to deliver the course for one year are a combination of course fees and student wages for time spent in the course. Estimates of the range of course fees are based upon fees currently charged by various providers offering similar courses, from more elementary syllabi to more comprehensive, accelerated degree programs. Sources included LinkedIn Learning, Udemy, ITPro.com, Boston College Global Leadership Institute, and Western Governor's University, among others. Completion rates are taken from reports from schools that offer fully remote certification courses published by the CIRR.

4. Effectiveness

Studies of self-initiated online education programs to date[59] find them to be **questionably effective**. Although the quality of available training is high, there are concerns regarding students' commitments and their willingness and ability to follow courses through to completion. Completion rates in self-initiated online courses are extremely low—on the order of 10 percent.[60] In credential-granting programs, only 30 percent of those who state an intention to earn the credential actually achieve it. This compares unfavorably with the approximately 40 percent certificate completion rate at traditional community colleges and approximately 80 percent completion rate of boot camp programs. Therefore, relying on self-initiated training and education would not be an effective way to raise the overall digital capabilities of the defense workforce.

5. Potential Risks

There are **low risks** associated with encouraging the workforce to pursue personal enrichment through online learning. Compensating employees for successful achievement of accredited certificates or degrees in target fields would limit costs while incentivizing completion. Without coordination across the Department, there is some risk that self-selected courses of studies would lead to a surplus of skills in some areas without addressing shortfalls in others, or result in the Department paying for skills that it never uses. This outcome could be mitigated by offering individualized bonuses or compensation in advance for studies that are particularly applicable to Department needs and suited to the employees' existing skills. (At a certain point, these are no longer "self-initiated" studies, and there is risk of unintended adverse consequences if staff are concerned that "optional" education opportunities are actually mandatory.)

6. Implementation Issues

Because the Department would leverage existing outside resources under this proposal, issues associated with incorporating self-initiated training would be minimal. The biggest challenge would be establishing policies for reimbursement, quality criteria, and equivalences among competing offerings for the purpose of credentials or other job qualifications. This is especially true if completion of an online course can satisfy a mandatory qualification for a given position, or if graduates of certain online courses will be given preference over graduates of other courses on the same topic. Given the vast range of available offerings, it might be necessary to rely on third-party accreditation boards and

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[59] "MOOCs [Massive Open Online Courses] Haven't Lived Up to the Hopes and the Hype, Stanford Participants Say," *Stanford News*, https://news.stanford.edu/2015/10/15/moocs-no-panacea-101515/, accessed November 25, 2020.

[60] "MOOC Completion Rates: The Data," http://www.katyjordan.com/MOOCproject.html, accessed November 25, 2020.

rating services to set minimum standards and relative preferences. The effective adoption of this training model will also require consideration of students' incentives for committing to, and completing, self-guided coursework.

7. Synergies with Other Proposals

Self-initiated online education could be more effectively managed and applied in a context of skill-based credentials and skill tracking. Effectiveness increases when completion of a certificate or demonstration of ability leads to a promotion, preference for choice of posting, and so on. In a context of credentials or job qualifications, the value of credentials is tied to which positions require or prefer them. One potential problem with self-initiated training is ensuring that the Department takes advantage of new skills arising from training programs. The likelihood of wasted effort would be significantly reduced by instituting a manpower and skills tracking system similar to that discussed in Section 3.C, Proposal 3: Workforce Metrics and Tracking.

C. Proposal 16: Mandatory Digital Training for All DoD Employees

1. Description

In its first-quarter 2020 report, the NSCAI wrote:

> DoD …should require mandatory training designed to improve baseline AI literacy, either online or in person. The training should focus on end users and their ability to collect and manage data, and include a short introduction to AI with an emphasis on machine learning, data management, the capabilities and limitations of AI, software decision-making, probabilistic reasoning, and an introduction to the responsible and ethical development and fielding of AI. [This] training should be mandatory for five years, followed by an assessment of the need to continue the training.[61]

In a footnote, the NSCAI added: "Among other things, mandatory training is intended to teach end users to implement better data collection and management practices, and to direct that behavior towards enabling the development of better AI."[62] Although this language specifies training for "end users," the commissioners indicated in personal interviews that the intent of the recommendation was universal training for all DoD employees.

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[61] NSCAI, *First Quarter Recommendations*, March 2020, 37.

[62] NSCAI, *First Quarter Recommendations*.

2. Gaps and Objectives Addressed

This proposal is aimed specifically at improving the Department's ability to implement and use data science, AI, and machine learning, not only for military operations but in all enterprise functions. The NSCAI further recommended:

> The course should be structured with successive levels of comprehension, annual repetitions, and certification for different levels of competency. The course should include baseline instruction in the nature, development, limitations, and application of AI and data science and the basics of data management. Instruction related to the responsible and ethical development and fielding of AI should also be included.[63]

This proposal primarily affects education and training, with potential secondary effects on competency and certification if tiered training were to be adopted.

3. Cost

The dominant cost of universal training is the participant's time to take the course. DoD's total workforce numbers approximately 3 million, so each hour of coursework would cost 3 million hours of workforce time. The IDA team modeled the cost of the program by estimating development costs for a 1- to 3-hour, fully remote, online digital literacy course customized for DoD combined with the cost of participant time spent for one year of operation.[64]

Resulting cost estimates for the first year range from a low of approximately $103 million to a high of approximately $310 million. Almost all costs consist of student wages, with only a tiny fraction attributable to development of the course. The resulting per student cost for the first year of the customized mandatory workforce training option is estimated to range from a low of approximately $35 to a high of $100.

4. Effectiveness

Universal mandatory training typically has **low effectiveness**. Making the material accessible to people with widely varying jobs and educational backgrounds forces a "lowest common denominator" approach that both fails to cover important topics and can

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63 NSCAI, *First Quarter Recommendations*.

64 Estimates of the time to develop the course, assuming a low-complexity web-based learning mode, are based on figures for time to develop one hour of instruction from a series of studies by researchers from the Association for Talent Development. Salary data for developers is based on estimates for job titles for Instructional Designers on Salary.com. A median hourly cost for development of $46.50 was used. Salary data for students is based upon civilian salary by education pay rates for the full range of DoD Civilian employees derived from the DMDC Appropriated Fund (APF) Civilian Master File. A median hourly wage of $34.48 for students was used. All students are assumed to complete the course.

cause those with more expertise or experience in the subject area to lose interest. A 2014 study of mandatory training in the Department of Veterans Affairs noted:

> Mandatory training is traditionally unpopular, and there is a perception that it is ineffective and decreases motivation to learn. Some education theory-related barriers to learning that may reduce the effectiveness of mandatory training include employee resentment about their lack of control, lack of interest, perception of irrelevancy to their specific workplace context, and workplace time pressures. Considering the high cost associated with mandatory training and doubts about its effectiveness, organizations would be well served to more closely consider the benefits of their programs.[65]

Mandatory training is best justified when the issues addressed are both universally applicable and potentially unfamiliar to many workers, who will therefore not seek out self-initiated training. Compliance and ethics issues are the most common applications, including diversity training, equal opportunity, professional ethics, cybersecurity and protection of controlled information, and so forth.

5. Potential Risks

Mandatory training is **high risk**. As noted previously, mandatory training is universally unpopular with workers and thus reduces workplace morale. It also diverts time from mission activities, reducing overall productivity. For the specific case of mandatory training in data science, AI, and machine learning, a single, common curriculum would be unlikely to provide substantial improvement in workforce capabilities. Although the NSCAI language seems to imply a vision of multiple levels of certification, it is hard to see how this goal could be accomplished through universal mandatory training of any kind. (The possibility of focused training for specific occupations or job descriptions, with credentials or tiers of certification, is addressed elsewhere in this report.)

The IDA team concludes that it would be more effective to incorporate relevant information on data science, AI, machine learning, and other DE disciplines into job-related training so that it could be immediately relevant to employee duties. This approach contrasts with trying to create a single course, or even a single set of courses, to provide a common set of knowledge to all 3 million military and civilian employees of the Department.

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[65] Kim Peterson and Ellen McCleery, "Evidence Brief: The Effectiveness of Mandatory Computer-Based Trainings on Government Ethics, Workplace Harassment, or Privacy and Information Security-Related Topics" *VA Evidence Synthesis Program Evidence Briefs*, May 2014, https://www.ncbi.nlm.nih.gov/books/NBK384612/.

6. Implementation Issues

As noted previously, the defense workforce is enormous, and any mandatory training that applies across the entire force represents a major investment of time and effort. Every hour of force-wide mandatory annual training consumes more than 1,400 staff years of labor, plus the overhead of providing and maintaining the training materials. The Department and the individual components have been working to reduce, rather than increase, the number of mandatory training requirements and the number of hours required by each.[66]

7. Synergies with Other Proposals

Mandatory, universal training content provided to all of DoD would necessarily be redundant with more targeted and in-depth training and education using boot camps, self-initiated online training, or other existing educational resources, such as DAU. As a result, there are negative synergies between this proposal and other proposals that involve education and training.

[66] Government Accountability Office (GAO), *DoD Training: DoD Has Taken Steps to Assess Common Military Training*, GAO-17-468, May 2017.

6. Careers, Competencies, and Compensation

A. Proposal 17: Functional Career Managers

1. Description

Within DoD, career management of personnel in the Acquisition workforce is distributed. Each military department has a Director for Acquisition Career Management (DACM) who is responsible for managing the integrated execution, oversight, and resourcing of acquisition education, training, and talent management for both uniformed and civilian acquisition workforce personnel. There is also a DACM for the more than 30 "fourth estate" defense agencies and field activities outside the military branches. Under the umbrella of acquisition, these DACMs provide career management services and track workforce trends across 15 specific acquisition-related career fields such as Auditing, Contracting, Life Cycle Logistics, and Program Management. They also coordinate with the OUSD(A&S) Human Capital Initiatives (HCI) office, which is charged with implementing Department-wide acquisition workforce policies and initiatives developed by the Workforce Leadership Team.

The DACMs are examples of *functional career managers*—central authorities for coordination and management of workforce initiatives for a subset of the DoD workforce defined by its function. Another example of the functional career manager construct is NICCS, as described earlier in Section 3.C, Proposal 3: Workforce Metrics and Tracking.

2. Gaps and Objectives Addressed

In the general economy, several career paths are well-defined and well-understood (such as doctors and lawyers). On the other hand, career paths in software development, AI, "big data" analytics, model-based systems engineering, human-machine interface design, and all of the other DE competence areas identified by the Senate are not as well-defined. At present, there is little or no formal recognition of career paths for these fields within the Department. Similarly, there is little support for individuals attempting to improvise such a career path within the strictures of existing military and civilian career field options.

This proposal would enable "career pathing" and associated workforce management and tracking capabilities by creating DE workforce functional management organizations. These organizations would have authorities and responsibilities for recruiting and hiring, education and training, career path definition and management, licensing and certification

requirements, and talent management functions analogous to those in place for the acquisition workforce. This infrastructure would substantially support coherent career planning and talent management of DE-focused individuals. The advantages of such pathing for software professionals has already been recognized in the commercial sector.[67]

3. Cost

Key cost drivers for functional career management would be the number of separate functional career fields defined, and whether each would have scope over civilians, enlisted personnel, and/or officers. We modeled costs based on the assumption that DE functional career managers would have similar scope, structure, and roles and responsibilities as DACMs. There would be a career manager for each military department and one for the Fourth Estate, for a total of four. Each career management office would have a government staff of six, led by an SES. The estimated personnel costs for this government staff would be $1.2 million per office. In addition, each office would be allocated a budget of roughly $1.5 million for analytical support, facilities, and administration. The estimated rough order of magnitude costs is therefore $2.7 million per office, and a total of $10.8 million.

4. Effectiveness

The IDA team projects that establishing functional career managers for digital professions overall, or separately for specific subfields, could be **highly effective**. Experience with the cyber and acquisition workforces has shown that articulated career paths and independent support organizations for those careers enhances recruiting, retention, and workforce quality. There is also strong evidence from the private sector that separately managing the workforce within "job families" improves workforce outcomes.[68] Importantly, having functional career fields organized by technical specialty as well as by application area makes both military and civilian service attractive to a wider range of potential workers.

5. Potential Risks

There are **moderate risks** associated with establishing functional career management. The principal risk is that the specific functional areas might be defined in ways that conflict with existing management structures, do not map well to current or future career paths of interest to the workforce, or do not provide the management visibility and tracking needed to support talent management and workforce assessment. If a single, overarching functional

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[67] Steven McConnell and Jenny Stuart, *Career Pathing for Software Professionals*, Construx white paper version 4.3.3, December 2019.

[68] Peter Levine, *Civilian Personnel Reform at the Department of Defense: Lessons from the Failure of the National Security Personnel System*, IDA Paper NS P-8656 (Alexandria, VA: Institute for Defense Analyses, October 2017), 60.

manager for digital careers were established, that office would require expertise across a wide range of technical fields and might be bureaucratically unwieldy. For digital fields that already have functional managers for at least some of the workforce, such as Cybersecurity or Modeling and Simulation, there is a risk of confusion regarding which functional manager a given career would fall under for defining certifications and credentials or tracking workforce competencies and trends.

If separate functional managers were established for individual digital career fields, they would need to be carefully defined so they comprised coherent career paths while also covering all of the skill areas and capability gaps identified under Proposal 2. At the same time, a civilian pursuing a career in software development might move in and out of the acquisition workforce over time. As a result, there is potential for conflicting or confusing authorities between the new career fields and existing career fields under HCI.

One approach to resolving these potential conflicts would be to allow individuals to choose their functional careers. Thus, a software architect working on machine learning applications in support of contracting decisions might, with identical skills, be in the middle of a career in software engineering, or a career in AI, and so on.

6. Implementation Issues

As noted previously, the details of how functional career fields are apportioned, and how they reconcile overlaps in their respective workforces, can be critical in determining success or failure. It would be easy to overlook important disciplines or define an unmanageable number of sparsely populated career fields. It would also be easy to combine too many unrelated professional specialties into a single "function" and thus lose the benefits of management by job family. Careful consideration by many stakeholder communities would be required to achieve the appropriate set of functional career groupings and to define their interactions with existing organizations and authorities.

7. Synergies with Other Proposals

The challenges of skill tracking and competency systems for multiple, interlocking functional areas have obvious synergies with the skill-based workforce tracking and talent management initiatives of Proposals 3 and 23. Skill-based credentials could be used to assess suitability for a specific work role or position, independent of career field or long-term career goals. This approach would also align with the recent shift from education-based or certification-based job qualifications in favor of qualifications based on more granular and dynamic skill credentials. In addition, DE functional managers should have responsibility over any new MOS or civilian occupations that are created for DE specialties.

B. Proposal 18: New Military Occupational Specialties for Software

1. Description

In their 2019 report, *Software Is Never Done*,[69] the DIB recommended that the Services add "[c]ore military occupational series (MOS) …for software development that include subcategories to address the various duties found in modern software development (e.g., developers/engineers, product owners, and designers)." Some MOS along these lines do exist. The Air Force has an enlisted specialty in Computer Systems Programming and the Army has added an MOS for cyber tool developers.[70] However, there is still no consistent treatment of software developers within or across Services or outside the cyber domain. The Navy has a rating for Information Systems Technician, which includes some computer system analyst skills but does not have a rating focused on software development. The Marine Corps formerly had a Data Systems Occupation Field that included enlisted MOSs of Programmer, ADA and Data Processing Chief, but that series was discontinued in 2005. The only current software-related MOS in the Marine Corps is Intelligence Software Security Engineer within the Signals Intelligence career field.

This proposal would establish an MOS specifically for software developers in each military department, with (potentially Service-specific) subcategories aligned with both current and desired future software development roles within those Services.

2. Gaps and Objectives Addressed

This proposal is specific to software development, with only indirect effects on other DE skill sets. Establishing a new MOS has potential effects on recruiting, education and training, competency and certification, career tracks, and talent management. Establishing a career track specific to software development could allow the Services to attract higher quality recruits specifically interested in software development who otherwise would not have been interested in a military career.

There are other DE specialties that also lack a distinctive MOS at present. Establishing new MOSs for data science, AI, machine learning, or robotics and autonomous systems would face significant barriers in clearly defining those fields and distinguishing them from existing MOSs for operations research and engineering.

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[69] DIB, *Software Is Never Done*, 14.

[70] Mark Pomerleau, "The Army Wants More Coders Alongside Operators," accessed November 27, 2020, https://www.fifthdomain.com/dod/army/2019/09/05/the-army-wants-more-coders-alongside-operators/.

3. Cost

Although the specific details differ across Services, creating a new military MOS has two parts: (1) a quarterly or annual bureaucratic process in which many different stakeholders submit comments on proposals and (2) training for the new personnel.

The bureaucratic process involves many stakeholders reviewing and commenting on the MOS. We estimated that it would cost roughly $50,000 to establish the process along with the same annual cost thereafter. We derived these numbers by examining the Army's process and assuming that each step required three days for an O-5 to complete. No doubt, the steps vary in difficulty, and some participants are more experienced than others. However, this figure seemed like a reasonable rough estimate of the effort, which totaled 48 days. There are about 220 workdays in a year, meaning that this process requires 48/220 = 0.22 of the cost of an O-5. According to FCoM, an Army O-5 in Washington, DC, costs DoD $240,000; therefore, the cost of this process is roughly $50,000.

For the training cost through initial MOS, the FORCES Cost Model estimates that the Army-wide cost per trainee ranges by MOS from $2,611 to $35,899. Digital engineers tend to be among the more highly trained specialties. An Army Geospatial Intelligence Analyst (35G) requires $17,405 in training per year; we round it and use $20,000 as the typical annual training cost for a digital engineer.

4. Effectiveness

Creating one or more new DE MOSs would permit individuals to specialize and gain experience and expertise to be strong, technically proficient leaders. The Services would benefit substantially from having such in-house expertise. The creation of a new MOS would also provide a focus for assessing the requirement for the covered skills. Without an appropriate MOS, the military Services would find it difficult to identify a need, or a gap, to be filled by recruiting and training. To enhance DE skills in the military, we estimate that this approach could be **moderately effective**—however, creating new MOSs could also have negative consequences, as discussed next.

5. Potential Risks

There are **moderate risks** associated with establishing new DE-related MOSs in the Services. Currently, the vast majority of MOSs are based on military domain applications—artillery, signals, or acquisition—rather than on academic disciplines. The exceptions tend to be treated distinctly from the fighting forces and managed separately (both for assignment and for promotion). Creating new categories of separately managed personnel within a rank-based, hierarchical organization poses challenges to organizational cohesion and morale. This situation is exacerbated if the new specialties cut across existing specialties in complex ways.

Effectively deploying the new specialties within existing commands and missions also presents challenges. As an historical example, the Department has sometimes found it difficult to efficiently and effectively use uniformed foreign language translators. Assigning skilled individuals throughout operational units does not tend to put the right person in the right place at the right time. However, organizing translators into deployable units is inefficient in other ways.

6. Implementation Issues

Creating an MOS for software development would not necessarily improve the recruiting, hiring, retention, career management, or effective use of software developers within the uniformed workforce. There are many implementation details to consider; for example, the MOS must be incorporated into a coherent career management construct. If the MOS includes an officer corps, two distinct career management constructs must be integrated and reconciled. The Services could also choose to make Software Officer a specialty career, as is currently done with healthcare, legal, and other professions. They could also consider expanding the scope of Warrant Officers for such positions. All of these options can cause complicated side effects in terms of promotion and Service-wide morale.

7. Synergies with Other Proposals

A new MOS would facilitate improved tracking and management of software careers in the uniformed military, but it would not by itself accomplish much. Its value would depend on the degree to which it enabled the Department to implement targeted recruiting and hiring, education and training, career tracking, talent management, and promotion and compensation initiatives for DE professions. As such, the establishment of a well-designed MOS taxonomy for software careers can be seen as a multiplier on the effectiveness of other proposals targeted at those career management activities.

C. Proposal 19: New Civilian Career Fields

1. Description

As discussed under Proposal 3, positions in the federal civilian workforce are classified according to a PCS taxonomy whose basic structure has not kept up with changing patterns of U.S. employment. In particular, occupations relating to software and other DE specialties have been added to the schedule haphazardly and inconsistently. The PCS taxonomy is also inconsistent with the SOC taxonomy used by the BLS and other agencies for statistical analysis of the U.S. workforce, and thus with the O*NET database as well.

This proposal would revise and expand the PCS to include new occupational series for distinguishable jobs and careers related to software development, data science, and other DE professions.

2. Gaps and Objectives Addressed

As noted under Proposal 3, the inability to identify workforce personnel who perform DE functions, or which personnel have the necessary skills for specific positions, is a serious barrier to efficient and effective workforce management. Aligning occupational classifications more closely with desired skills would help considerably—especially if the new classifications were sufficiently aligned with O*NET taxonomies to directly compare workforce demographics, compensation, skills, and mobility between federal civilians and the private sector. The benefits of an updated taxonomy would accrue across all affected occupations and throughout the workforce management cycle, from recruiting and hiring through talent management.

3. Cost

Creating a civilian career field requires a bureaucratic process similar to an MOS, but differs in that no training costs are associated with it because people are hired based on their qualifications. If training would be provided, it would fall under one of the other proposals in this paper. We estimate the total cost at $50,000 in the beginning and $50,000 per year thereafter.

4. Effectiveness

We estimate that creating new, appropriate occupational codes for key careers such as software development and data science would be **effective** in improving the talent management of DE skills within the Department. Experience with economy-wide workforce tracking at the BLS shows that important insights can be lost when the taxonomy of occupations does not reflect the current workforce, and when important skill sets are not associated with identifiable career fields. However, defining new career fields would not be enough to identify, track, and manage DE skills in the defense workforce.

5. Potential Risks

There would be one-time administrative friction and workforce confusion during the change-over from the old taxonomy to the new. If the new series were simply added to the schedule without replacing the old series, there would continue to be confusion regarding which parts of the workforce were engaged in which DE activities. There is also a risk that the new series would become obsolete in the near future, as fields like software development and data science evolve rapidly. This is particularly true if the new series were aligned with the expanded O*NET SOC taxonomy, which also changes rapidly.

6. Implementation Issues

As with any taxonomy-based effort, defining the right set of categories and subcategories is vital to getting value out of the effort. The occupations should correspond to coherent careers that can be planned and pursued and that align with specific DE skill sets as much as possible.

7. Synergies with Other Proposals

There are significant synergies between defining new civilian occupations and other proposals assessed in this report. In particular, the value of new occupational codes could be greatly enhanced if combined with civilian rotational career paths (Section 6.H) and Functional Career Managers (Section 6.A). At the same time, adopting credential-based skills tracking (Section 6.G) would render changes to occupation codes much less relevant, and the two efforts could potentially conflict.

D. Proposal 20: Market-Based Pay for DE Civilians

1. Description

The market-based pay for DE civilians would be a skill-based pay similar to those already in use in the public and private sectors. On the military side, the Department has long offered special pays for aviators, doctors, lawyers, and other hard-to-fill career fields. On the civilian side, the Department offers physicians' comparability allowances (PCAs) to attract and retain doctors. On a selected basis, it allows increased pay for highly qualified experts and other special skill sets. In addition, DoD runs a number of flexible pay systems, such as the Acquisition Demonstration program (AcqDemo), the Laboratory Demonstration program (LabDemo), and the Defense Civilian Intelligence Personnel System (DCIPS), which contain elements of market-based pay as well as pay for performance.

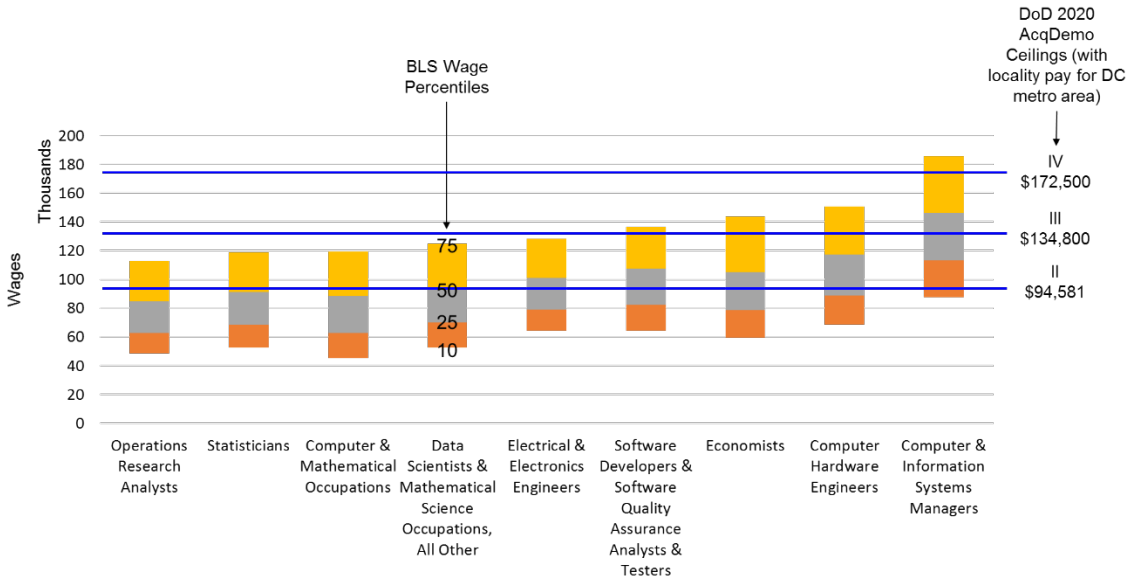
2. Gaps and Objectives Addressed

The availability of market-based pays provides DoD components with the flexibility to offer competitive compensation and to adjust offers in adapting to changing labor market conditions. DE skills are in very high demand and DoD must provide sufficient compensation to attract and retain a workforce with the caliber of skills and talent to execute national security missions. The gap this proposal addresses is that some jobs requiring DE skills may not be covered by DoD's flexible pay plans.

3. Cost

The estimated cost of this proposal is based on the Department's experience with the AcqDemo program.[71] The AcqDemo pay system began in 1999 with 4,000 participants and covers 45,151 civilians as of 2019. Many civilians within the DE workforce are already covered by market-based pay systems such as AcqDemo. This proposal would extend market-based pay to the entire DE workforce.

Figure 4 shows the distribution (percentiles) of salaries across the U.S. economy for several occupations relevant to the DE workforce: analytical, data science, software, and computer engineering. The AcqDemo Payband II offers above median salaries for four of the seven occupational groups in the figure, but does not reach the 75th percentile for any of the occupational groups. Payband III allows for pay that meets or exceeds the 75th percentile of pay for five of the seven U.S. occupational groups. Payband IV roughly meets or exceeds the 90th percentile for all of the occupational groups, with the exception of computer and information systems managers.



Source: Bureau of Labor Statistics May 2019 Occupational Employment Statistics Survey, www.bls.gov/oes, oesinfo@bls.gov

Figure 4. Civilian Pay (AcqDemo) vs. the Overall Economy

The cost associated with this proposal equals the marginal increase in pay resulting from the adoption of a market-based pay system tied to DE skills. The IDA team estimated this pay differential using DoD data. A comparison of compensation under the AcqDemo program with comparable job classifications under the GS scale shows that for technical

[71] OUSD(A&S), Human Capital Initiative, *What We Do: DAWDA*.

experts, there is an average 4.9 percent compensation differential.[72] This translates into a pay premium of $4,000 to $8,000 per year for the most relevant pay grades.

4. Effectiveness

We judge market-based pay to be a **highly effective** management tool. DoD has decades of experience managing market-based pays. The increased pay levels available under the pay plans described previously have all proven effective in attracting needed skills and talent.

5. Implementation Issues and Risks

DoD has well-established mechanisms for implementing market-based compensation; therefore, the administrative issues in implementing this proposal appear to be minimal. The risk, as with any variable pay system, is that the intense market competition of DE experts may create issues with balancing the market-based pay for DE personnel with the compensation available for other occupations. In addition, pay-for-performance systems have encountered pushback from employees and opposition from employee unions. Overall, we judge this to be a **low-risk** option.

6. Synergies with Other Proposals

The ability to offer compensation that attracts and retains needed personnel is the foundation for building an effective DE workforce. Thus, this proposal complements all the other proposals. In particular, the pipeline initiatives targeted at recruiting high levels of DE skills would be more effective if the compensation system were designed to increase retention.

E. Proposal 21: Special Pays for DE Military Personnel

1. Description

The special pays for DE military personnel would be skill-based pays similar to those already in place for several military specialties. A recent IDA analysis for the Quadrennial Review of Military Compensation[73] describes the flexibility the Congress has provided

[72] In order to calculate differences in salaries that might result from the use of a different pay system, the IDA team employed the DMDC's DoD Personnel Master File. For AcqDemo, we calculated average salary by occupational series and broadband level for each of the three career tracks. For GS, we calculated average salary by occupational series and pay grade. For comparison between the two systems, we used the GS paygrade-AcqDemo equivalency conversion suggested by AcqDemo.

[73] Department of Defense, *Twelfth Quadrennial Review of Military Compensation*, accessed November 27, 2020, https://militarypay.defense.gov/References/QRMC/.

DoD to target extra pay where necessary to address readiness issues.[74] In all, there are 12 categories of special and incentive pays and a total of 60 pays stipulated by the Congress within those categories.[75] Special pays allow for the targeting of compensation as well as the flexibility to adjust special pays as conditions change.

2. Gaps and Objectives Addressed

DE skills are in very high demand, and DoD must provide sufficient compensation to attract and retain a workforce with the caliber of skills and talent to execute national security missions. Special pays allow the military components to offer competitive compensation and to adjust offers as labor market conditions change.

Figure 5 shows the distribution (percentiles) of salaries across the U.S. economy for several occupations relevant to the DE workforce: analytical, data science, software, and computer engineering. The figure shows that O-3 military pay (calculated as the sum of cash compensation: salary, housing allowances, plus subsistence pay) equals or exceeds the 75th percentile salary for all but one of the occupations. Military pay at the O-4 level is at or above the 90th percentile for three of the occupations, but remains well below the 90th percentile for the more competitive occupations. Military pay at the O-5 and O-6 levels are quite competitive relative to overall U.S. markets. In DE fields where U.S. competitive salaries are relatively high for junior personnel, there can be a gap between military pay and U.S. wage patterns in the lower ranks. Special pays could be targeted to address this gap in pay.

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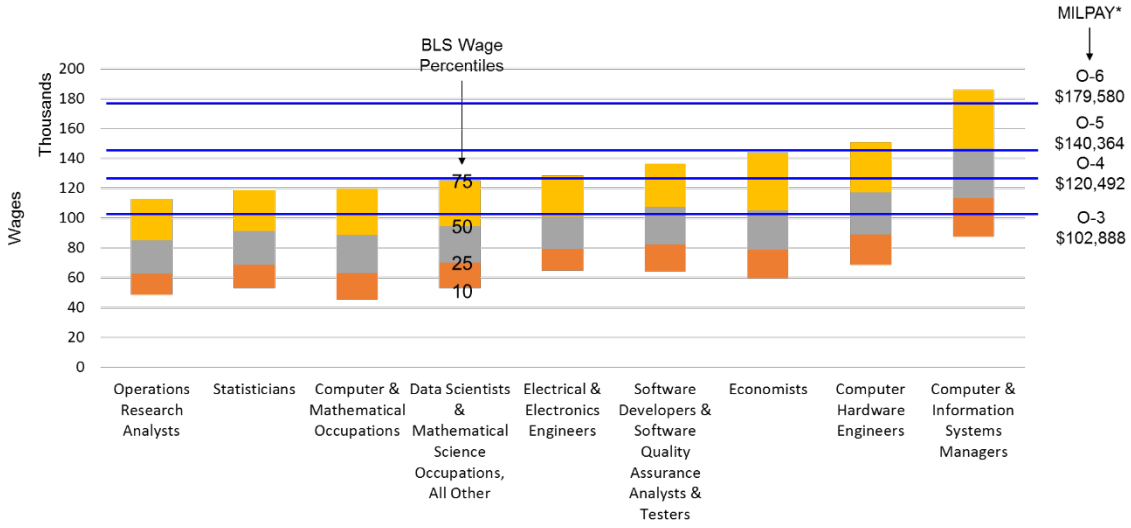
[74] Nancy Huff et al., *Analysis of a Salary-Based Pay System for the Quadrennial Review of Military Compensation*, IDA Document D-13204 (Alexandria, VA: Institute for Defense Analyses, April 2020).

[75] Department of Defense, "Title 37, Chapter 5, Subchapter I – S&I Pays Currently for Active Duty Service Members," accessed April 15, 2020, https://militarypay.defense.gov/.



Source: Bureau of Labor Statistics May 2019 Occupational Employment Statistics Survey, www.bls.gov/oes, oesinfo@bls.gov
*MILPAY (Regular Military Compensation = Basic Pay + Housing (Quantico, with dependents) + Subsistence)

Figure 5. Military Pay vs. the Overall Economy

3. Cost

The design of a special pay system for DE skills will require analysis of U.S. labor market conditions and internal DoD workforce conditions and trends. However, some indication of the rough magnitude of the cost of such pays can be obtained by examining DoD's current special pay programs. In aggregate, DoD's special and incentive pays amount to $7.7 billion, which is just under 9 percent of total current cash compensation.[76] However, pays vary across occupations, so the cost of incentives for DE skills could deviate substantially from that average. Several examples illustrate the application and range of special pays:

- The Foreign Language Proficiency Bonus can be up to $12,000 per year at the discretion of the Service.
- The Aviation Career Incentive Pay ranges from $1,500 to $10,800 per year, determined by years of aviation service as an officer.

One of the highest special pay packages is for a board-certified neurosurgery specialist in the Navy (a 210x with 15D1 subspecialty) who would receive special pays of $12,000 for the board certification, $36,000 for incentive special pay, and $10,000 for variable special pay totaling $58,000 each year.[77] These DoD data indicate that special pays average about 9 percent of base pay, and this translates into a pay premium of $9,000 to $15,000 per year for the most relevant pay grades.

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[76] DoD, "Title 37, Chapter 5, Subchapter I."

[77] This calculation is from FCoM.

4. Effectiveness

The Services have found this to be an **effective** management tool. The Services have decades of experience managing special pays, which have contributed to recruitment and retention. However, when there are exceptional competitive pressures in the civilian marketplace—as has sometimes happened for pilots—the military special pays have been insufficient to retain needed personnel.

5. Implementation Issues and Risks

The Services have well-established mechanisms for implementing special pays, so there are no administrative issues in implementing this proposal. Special pays could be designed and targeted to address the DE skill areas in which DoD must provide more compensation to remain competitive. Ongoing analyses of the U.S. labor markets, as well as internal DoD workforce trends, will be needed to provide the basis for establishing special pays.

There is a **moderate risk** that allowable special pays are not sufficient to attract and retain needed talent. Another issue and risk, as with any special pay, is that the intense market competition of DE experts may create issues in balancing the competitive pay for DE personnel with the compensation available for other occupations. Moreover, if the pay for DE occupations becomes too high, it could create pressure for increases in other occupations and an overall escalation of pay.

6. Synergies with Other Proposals

The ability to offer compensation that attracts and retains needed personnel is the foundation for building an effective DE workforce. Thus, this proposal complements all the other proposals. In particular, the pipeline initiatives targeted at recruiting high levels of DE skills would be more effective if the compensation system were designed to increase retention.

F. Proposal 22: Expanded Public-Private Exchange

1. Description

The structures of civil service jobs and hiring processes make it difficult for individuals to move between the private sector and federal service. As a result, there is less cross-pollination between the federal workforce and the commercial workforce than DoD would like. Talented individuals in each sector face significant disincentives and logistical barriers to moving to or from the federal workforce. This situation makes it difficult both for the Department to access the best talent in industry and for federal civilians to get valuable experience on the contractor side of the public-private partnership.

To alleviate this problem, the Congress has provided the Department with limited authorities to conduct public-private exchange programs (PPEPs) in which federal employees work for private companies, or private-sector (or non-profit/NGO) employees works as government employees for limited periods subject to certain restrictions. The best known such authority is the 1970 Intergovernmental Personnel Act (IPA), which was originally designed to permit temporary detailing among the federal government and state and local governments. The act was later expanded to include the temporary exchange of staff between the federal government and nonprofit research or educational organizations or federally funded research and development centers (FFRDCs). Other DoD-unique PPEP authorities, focused on exchanges with commercial industry, were added in 2016 and codified at Title 10, United States Code, Section 1599g.

This proposal would expand those authorities to a significantly larger number of participants and relax existing restrictions and constraints on using the exchange mechanisms. Civilians would rotate from government to private industry and back (or vice versa) for a temporary detail of defined duration and scope.

2. Gaps and Objectives Addressed

The federal government, including DoD, has difficulty attracting top digital talent. There are many reasons for this, including pay disparities, lack of defined digital career paths in the federal service (see Proposal 17), and federal conflict of interest regulations that impose restrictions and limitations on the careers of people who move between the federal workforce and the private sector. Congressionally authorized rotation programs seek to overcome some of those barriers by:

- Permitting participants to remain on their chosen career path with a promised place to return to (or move on to) at the end of the temporary rotation
- Addressing conflict of interest and post-employment concerns so that rotation programs can proceed in a manner consistent with the public interest
- Paying industry participants their market salary regardless of the grade of the position they temporarily occupy

This proposal would expand these programs, providing valuable job experience to federal employees and potentially covering the full range of digital skills needed in the federal workforce.

3. Cost

The principal cost drivers for PPEPs are (1) the administrative costs of managing applicants and matching them with positions, and (2) the costs per exchange to pay relocation costs, any salaries differences, and opportunity costs (e.g., lost consulting or

research grant income) for industry and academia participants. These costs total between $15,000 and $20,000 per exchangee.

The salary of each exchangee can be handled differently. Sometimes the accepting organization pays; other times the originating one does. We assume that the net cost is zero, with the salary of exchangees being constant and covered by their home employer.

The American Association for the Advancement of Science (AAAS) runs a fellowship program that places scientists into the federal government for 1 to 2 years. In 2020, the program had 248 fellows in the government and a staff of 21. If the average staff member cost AAAS $100,000, the administrative cost per fellow is $7,000. Thus, this is our estimate for the administrative cost.

Each exchange also would require a relocation at the beginning and end of the assignment. Moving costs vary tremendously based on how much goods a person owns and the distance they move. The cost of a cross-country move for a family would be approximately $10,000.

4. Effectiveness

Depending upon implementation details, PPEPs can range from **moderately to highly effective**. Past research has described them as "a 'triple win' for the destination organization, the exchangee, and the home organization.[78] The potential benefits of a rotational program include valuable job experience, exposure to state-of-the-art private sector practices, and improved recruiting and retention due to more flexible and engaging career experiences. The factors determining the use of PPEPs (and thus effectiveness) are discussed next.

5. Potential Risks

There are **significant risks** associated with PPEPs. The effective use of PPEPs requires striking a balance between protecting the objectivity and fairness of inherently government functions while achieving a useful type and volume of talent exchange. Movement of key personnel between the government and the private sector, especially in a context of product development or acquisition, creates a potential for conflict of interest, improper influence, inadequate protection of trade secrets and proprietary business information, and other abuses.

The historical countermeasures used to limit such abuses have been significant reporting requirements and post-employment restrictions. Reporting requirements include the disclosure of financial holdings and other potential organizational conflicts of interest.

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[78] Susanna Howieson et al., *Federal Personnel Exchange Mechanisms*, IDA Document D-4906 (Washington, DC: Institute for Defense Analyses, Science and Technology Policy Institute, November 2013).

Restrictions include bans on representing or dealing with the government or the private entity in subsequent interactions, and bans on receiving compensation from the private entity for a period after the rotation.

For PPEPs to enhance digital talent in the Department effectively, that talent must be able to work on the most useful jobs. However, this situation can create issues. For example: An individual who completes a rotation at a helicopter manufacturing company to become knowledgeable about the latest DE techniques for rotorcraft is then forbidden to work on helicopter programs for years thereafter due to the potential for conflicts of interest. Not only is the Department unable to use efficiently the enhanced skills and knowledge that resulted from the rotation, but the individual's career path could be seriously interrupted or even derailed.

Another risk of PPEP rotations is that quality individuals from the government can be lured to private industry by the promise of higher salaries, better working conditions, and better career path options. Although individuals who have been involved in acquisition are usually restricted from accepting compensation from an involved company for a period of one year after the end of the rotation, there are generally no such restrictions for individuals not involved in acquisitions.

6. Implementation Issues

As noted previously, the primary issue with PPEPs in the past has been trying to balance the risk of abuse and the value of the exchange. Subjecting exchangees from industry to the same statutory rules (and penalties) as federal employees reduces the risk of abuse, but also poses significant barriers to participation. Even individuals with no intention of breaking the law can be deterred by complicated financial disclosure requirements, background checks, and other impediments. The threat of criminal prosecution for inadvertent improper disclosure of proprietary information or trade secrets is likewise daunting. Similarly, post-exchange employment restrictions can have pernicious effects, preventing people who have just acquired useful expertise from applying that expertise where it is needed. Oversight mechanisms are needed that provide appropriate protection against waste, fraud, and abuse without crippling the ability of the government to leverage private industry expertise or to expand the skills and experience of key employees through details in the private sector.

7. Synergies with Other Proposals

PPEPs could be combined with rotational cadres of digital experts (Section 4.I) or civilian rotational career paths (Section 6.H) to expand the options for temporary placement of federal employees. Combining both intra-governmental and extra-governmental exchange proposals under a single management construct, such as Functional Career Managers (Section 6.A), could also increase the effectiveness of both options.

G. Proposal 23: Credential-Based Skills Tracking

1. Description

As discussed in Sections 3.C and 6.A, there are significant benefits to being able to track the specific skills of the workforce, in addition to (or in lieu of) their educational backgrounds and occupations. This is especially true when the taxonomy of occupational codes (military or civilian) is poorly aligned with the specific skills for talent management and workforce enhancement. This proposal would implement skills-based tracking of worker competencies through defined credentials applicable to a variety of careers and work roles.

2. Gaps and Objectives Addressed

Chapter 3 describes the inability of current workforce data collection and metrics to answer fundamental questions about the DE capabilities of the defense workforce. This is a significant barrier to identifying DoD-wide requirements for enhanced DE skills, recruiting appropriate talent, designing training programs, and measuring success. Credential-based skill tracking, if done correctly, can mitigate all of those challenges.

3. Cost

The closest analogy to skills-based tracking is the Department of Homeland Security's (DHS) NICCS portal. DHS breaks up all cybersecurity knowledge into credentials that can identify skills and experience for specific jobs, just as we propose. The cost of that program can be found in the NICCS budget.[79] The cost of the staff to stay current on all skills and maintain the webpage is $9 million per year.[80]

4. Effectiveness

Based on historical precedents, the IDA team assesses that credential-based skills tracking in a context of portable credentials would be **highly effective** at improving the visibility of workforce gaps, facilitating talent management, adapting to changing work role requirements, and matching appropriate personnel to specific positions.

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[79] Department of Homeland Security, Cybersecurity and Infrastructure Security Agency, "Budget Overview," https://www.dhs.gov/sites/default/files/publications /cybersecurity_and_infrastructure_security_agency.pdf, 110.

[80] The budget line for maintaining the webpage is called "NICCS Portal" and was $2 million in 2019; the line for "Training and Workforce Development" was $7 million. We cited the 2019 entry because after that, the Training & Workforce Development line added significant costs that are described in the budget.

5. Potential Risks

There are **moderate risks** associated with this proposal. The principal risk in any taxonomy-based measurement and management system is that success depends strongly on defining a good taxonomy up front. If the taxonomy of skills does not align with the required abilities, the benefits for gap analysis and talent management will be minimal. Similarly, skills must be measurable. If having a credential does not guarantee having the needed skills, the system will fail.

6. Implementation Issues

As noted previously, choosing a good taxonomy of skills is vital. A balance must be struck between skills that are too specific (and thus useful only in a handful of work roles) and skills that are too general to indicate whether an individual has the skills needed for a given work role. Similarly, when setting requirements for positions or work roles, only the necessary credentials should be included in the position requirements. Otherwise, the credential system becomes a barrier to workforce mobility and to talent management through a sort of "regulatory capture."

As noted previously under potential risks, for credentials to be of value they must be meaningful—possession of a credential must imply possession of the corresponding skills. This means that credential requirements must be carefully designed and periodically updated to align with changes in technology and in work roles. In most cases, credentials are designed to be temporary, requiring active refresher training and incorporation of any recent changes in requirements.

7. Synergies with Other Proposals

Skill-based credential tracking is a strong mutual enabler of several other proposals assessed in this report, including Functional Career Managers and new military or civilian career fields. The efficacy of boot camps and public-private exchanges could also be enhanced if those initiatives were conducted in a context of skill-based credentials.

H. Proposal 24: Civilian Rotational Career Paths

1. Description

As explained by an author of a 2019 article,[81] the civilian personnel system, unlike the military personnel system, is centered on positions of potentially unlimited duration. An individual hired for a particular position can be expected to remain there unless or until he or she moves to a new position. The next developmental position will become available

[81] Peter Levine, "Building a 21st Century Acquisition Workforce," *War on the Rocks,* May 6, 2019, https://warontherocks.com/2019/05/building-a-21st-century-defense-acquisition-workforce/.

only when it is vacated. This position-based system provides little opportunity for systematic career planning and progressive assignment similar to the military's rotational system.

This proposal would provide a mechanism for building civilian careers by developing a set of limited tenure positions that would be available to employees opting for a career-building track. Employees would be assigned to these positions to acquire needed skills and then move on to new assignments without giving up their employment status. Special periods for training and education could be built into the rotation system. To make the new system work, DoD would have to designate developmental positions that would be available for rotation at all levels of the organization, so that a wide variety of challenging future assignments would be visible to employees beginning their careers.

2. Gaps and Objectives Addressed

This proposal could build mid- to-high level expertise in the defense civilian workforce over time. It could be applied to all digital fields, including software development, DE, AI, and machine learning. This proposal would be particularly helpful for building and retaining individuals who can integrate critical skills into DoD mission sets and lead the critical skills workforce.

3. Cost

Creating these rotational billets does not add employees to the Department or require a large bureaucracy. Instead, functional career managers and line managers would handle these billets within the Department. There is some cost associated with moving people in and out of positions, but those costs are small. Relocation expenses around $10,000 per person per year are likely the only cost directly attributable to this initiative.

Some parts of the Department have previously converted permanent positions into limited tenure positions for reasons unrelated to rotational career paths, so there is precedent for the change. The conversion itself should not increase costs, because it would not change the nature of the work performed by individuals in those positions or their salaries.

The IDA team anticipates two major cost factors associated with this proposal: (1) the cost of education and training segments that are added to career paths and (2) the cost of managing the career rotation system. Ideally, the new program would be administered by functional career managers in the military Services, so the administrative cost of this proposal would be similar to the cost of the functional career manager proposal addressed in Section 6.A. The team estimates that one to two months of additional training and education would be added for every year that an employee remains in a rotational career program.

4. Effectiveness

The IDA team assesses rotational career patterns as an **effective** approach to building mid- to top-tier talent, particularly for developing individuals who can integrate multiple skill sets and manage DoD-unique functions. The rotational approach has proven highly effective at building leaders and managers on the military side. Efforts of limited scope have shown that the same approach can be effective in building the civilian workforce: both the Air Force and the Defense Logistics Agency have small rotational programs for future civilian leaders. A carefully targeted approach to build specific skills and capabilities within the defense civilian workforce could enhance capabilities not otherwise available among military or civilian employees.

5. Potential Risks

The IDA team assesses a **moderate risk** for this proposal. Creating rotational career paths for a select part of the civilian workforce could be perceived as establishing a privileged class of civilian employees. If not handled carefully, this approach could result in resentment and hostility against participants in the program, reducing morale in the overall workforce.

Frequently rotating civilian personnel would also create the risk of placing employees in positions that they have not yet mastered and moving them once they master the necessary skills. However, on-the-job training appears to be an essential element of any employee development program and pays for itself in the long term. As employees gain experience, the learning curve for new positions should become shorter and the payback period longer. The problem of moving employees to new positions as soon as they master their existing work could be addressed through assignment periods that are less rigid than the 2- to 3-year tours typical in the military.

6. Implementation Issues

Managing a rotational civilian cohort would require significant attention from senior management. It would also require support from mid-level managers in defense agencies and commands who would be responsible for managing the temporary billets. Such support might be facilitated by providing a central source of funding for the rotational program, so that the billet would be perceived as an added resource.

7. Synergies with Other Proposals

This approach would complement the training and mentoring approach of cohort hiring by offering career-long development opportunities to further entice highly qualified candidates to the DoD workforce. More highly qualified individuals are likely to participate if they can see that they are entering a program with a strong mission and potential for

growth and advancement. In addition, functional career managers would be ideally placed to manage the development of participants in a rotational program.

7. Summary and Next Steps

This chapter summarizes the top-level findings of our analysis and outlines a path forward. Although our analysis makes no recommendations, the findings suggest a number of factors that should be considered when developing a strategy for strengthening the DE workforce.

A. Assessments of the Candidate Proposals

Table 8 summarizes the IDA team's findings on effectiveness and risk for the 24 selected proposals, grouped into the four lines of effort: enabling measures; pipeline for new talent; training and education; and careers, competencies, and compensation. Because the proposals were screened and selected from a larger set of alternatives, most are found to be effective or highly effective. Similarly, in nearly all cases the risks are low or moderate.

Table 8. Assessment of the Effectiveness and Risk of the Candidate Proposals

Enablers: Requirements & Management			
Candidate Proposal	**Objective**	**Effectiveness**	**Risk**
DE workforce requirements analysis	Provide an understanding of the need for DE talent as the basis for strategy, planning & effective program execution	HIGHLY EFFECTIVE	MODERATE
DE manpower management	Provide the authority, information & resources to shape the DE workforce	HIGHLY EFFECTIVE	LOW
Workforce metrics & tracking		HIGHLY EFFECTIVE	MODERATE
Budgeting & resource management		HIGHLY EFFECTIVE	MODERATE

Pipeline for New Talent			
Candidate Proposal	**Objective**	**Effectiveness**	**Risk**
Hire STEM professors & students for summer breaks	Outreach to academic experts & increased access to highly skilled experts	HIGHLY EFFECTIVE	LOW
Provide fellowships w/stipends & summer employment		EFFECTIVE	LOW
Recruiting:			
STEM civilian recruiting offices	Provide focus, tools, trained personnel & authorities to overcome hiring barriers	EFFECTIVE	MODERATE
Digital force recruiting units for uniformed services		EFFECTIVE	HIGH
Cohort hiring		HIGHLY EFFECTIVE	MODERATE
Rotational cadres of digital experts	Strengthen outreach, develop talent & overcome hiring barriers	HIGHLY EFFECTIVE	LOW
Expanded SMART scholarships & C:SFS		HIGHLY EFFECTIVE	LOW
Defense Civilian Training Corps		EFFECTIVE	MODERATE
Digital Service Academy for Civilians		QUESTIONABLY EFFECTIVE	HIGH
Training & Education			
Candidate Proposal	**Objective**	**Effectiveness**	**Risk**
Digital boot camps	Provide intensive, residential training in focused skill areas	EFFECTIVE	MODERATE
Reimbursed online education & training	Provide opportunities for self-initiated training	EFFECTIVE	LOW
DoD-wide mandatory training	Provide introductory training for all DoD	QUESTIONABLY EFFECTIVE	HIGH

Careers, Competencies & Compensation			
Candidate Proposal	**Objective**	**Effectiveness**	**Risk**
Functional Career Managers	Identify & enable the management of critical skills	EFFECTIVE	LOW
New military occupational specialties		EFFECTIVE	MODERATE
New civilian career fields		EFFECTIVE	MODERATE
Credential-based skills tracking		HIGHLY EFFECTIVE	MODERATE
Special market-based pay for civilians	Foster recruitment & retention through competitive compensation	HIGHLY EFFECTIVE	LOW
Special pays for military		EFFECTIVE	LOW
Expanded public-private exchange	Provide career progression & mobility	EFFECTIVE	LOW
Civilian rotational career paths		EFFECTIVE	MODERATE

B. Observations

This section integrates the findings from the evaluation of the candidate proposals. Each of the four lines of effort is addressed in turn.

1. Enablers: Requirements and Management

Most independent reviews and reports assessing the digital workforce, and most DoD initiatives for the digital workforce, start with the assumption that the Department needs to upgrade its digital talent. The analysis then typically turns to the question of pipelines: What mechanisms should the Department use to acquire or build new talent in its ranks?

Although the assumption that the Department needs to upgrade its digital talent is likely accurate, it leaves many important questions unanswered: What types of talent does the Department need? How much? Where is that talent best placed—in the military, civilian, or contractor workforce? In which work roles, billets, or positions? What talent does the Department already have access to in these workforces?

Without answers to these questions, DoD risks acquiring too much of the wrong type of talent, perhaps leaving gaps elsewhere in its digital capabilities as a result. Moreover, without a requirements analysis, the Department will find it difficult to justify new positions or the budget needed to maintain them. There is a very real risk that the Department could build a pipeline of new talent without billets for it. In short, unless the Department identifies its requirement and manages that requirement (along with needed billets and budget), it is unlikely to make significant progress toward a more effective digital workforce.

For these reasons, the IDA team concludes that DoD should consider several critical enabling measures along with the pipeline initiatives more commonly recommended by independent reviews and reports. These measures include workforce requirements analysis, manpower management initiatives, workforce metrics and tracking, and budget and resource management mechanisms. A requirements analysis will help the Department understand what additional skills are needed, who will provide them and in what quantities, how the workforce will be structured, and what new or existing billets and positions will be needed. A manpower management system is needed to ensure that the Department can shape the DE workforce by identifying key competencies and managing the billets needed to shape them. Workforce tracking and metrics are needed so that the Department can optimize the deployment of existing talent and assess progress toward developing new talent. Budget and resource management—probably including the allocation of billets and a central fund to support workforce improvement activities—make it much more likely that planned initiatives will actually be carried out.

In practice, the Department could place these functions in a single central organization or establish a federated organizational structure with a small central organization that provides guidance to implementation units in the military departments and defense activities. This structural decision is unlikely to have a major impact on cost. Therefore, for our analysis, the cost of the key enabling functions is assessed based on the cost of establishing a central management activity, with a dedicated staff of federal employees and a budget for analytical support.

The startup costs include the extensive foundational data and analysis to establish DE workforce requirements, define and correctly size the specialized DE skill groups, establish a system of DE workforce metrics, and build the necessary budgeting and resource allocation mechanisms. The ongoing management costs would include continuous updates in management data and analyses and the administration of the four main enabling activities. (The administrative costs associated with functional area managers and other community-related activities are considered separately.)

Under this category of enabling measures, we include the costs associated with any expansion of the DE workforce required to execute the strategy. To some degree, the DE workforce will be created by strengthening the skills (and associated credentials) of individuals in established occupations, or by converting existing DoD billets to specialized DE specialties or occupations. However, where additions to the overall DoD workforce are necessary, we estimate the fully burdened cost of DE experts compensated at competitive rates would be around $150,000 to $300,000 per year.

Several pending decisions will shape how these enabling activities are carried out, and hence their costs. Costs will depend on the scope of the DE workforce strengthening initiative and the proposals adopted. Moreover, the costs will vary significantly depending

on the degree of managerial and analytical coordination between this initiative and other established or emerging DoD workforce improvement initiatives.

2. Pipeline for New Talent

Critical to strengthening the military and civilian digital workforce is the ability to bring in new talent. The proposals outlined for the talent pipeline include a mix of proven approaches for attracting skilled individuals to government service. They address three facets: (1) outreach efforts to increase the number of individuals exposed to DoD employment options, (2) recruiting efforts to identify and sign up individuals for government service, and (3) hiring processes to bring the desired new recruits into the DoD workforce. A fourth set of proposals ties together multiple phases of outreach, recruiting, and hiring by offering to pay for a recruit's education in exchange for a binding service commitment.

Most of the pipeline proposals considered have been proven in prior, similar applications and are expected to be either effective or highly effective and to carry low or moderate risk. The creation of special digital recruiting units for the Armed Forces carries higher risk (because of the potential disruption to established recruiting), but could be effective if appropriately implemented. The establishment of a Digital Service Academy for Civilians is a risky proposal that is unlikely to be effective because a new academic institution would be costly to establish and would likely find it difficult to compete with established civilian institutions for students and faculty.

Most of the pipeline proposals could be implemented at a cost of $20,000 to $100,000 per new recruit. For example, DoD's SMART scholarships cost roughly $48,000 per year for undergraduate students, $53,000 per year for masters' students, and $61,000 per year for doctoral students. Similarly, the IDA team estimates that the Department could hire academics to contribute to government projects over a summer for roughly $30,000 per student and $100,000 per professor. By contrast, an IDA research team recently determined that the cost per student of the USUHS (a DoD-specific academic institution and the closest analog for the proposed Digital Service Academy) is $268,000 per year for a four-year total of $1.07 million.

3. Training and Education

DoD will draw heavily on curricula and certifications from established military and civilian programs to educate and train the DE workforce. There are, however, a number of proposals for DoD-sponsored education and training programs that would complement existing programs. The proposals fall into three areas.

First are "digital boot camps." In the academic world, a typical boot camp program lasts 6 to 10 weeks, training a cohort of 20 to 30 students with the intent of making them employable at an entry level at the end of that period.

The second area is DoD-supported online training: taking advantage of formal academic courses and less formal training on topics relevant to defense DE and at various levels of presentation, from introductory to graduate-level instruction. Boot camps are assessed to be effective. Online training in isolation is questionably effective. However, it could be effective when systematically coupled with a career credentialing system that ties career progression and incentives to training accomplishments.

The third proposal is mandatory introductory training across the DoD workforce. Such training would be aimed specifically at improving the Department's ability to implement and use data science, AI, and machine learning, not only for military operations but in all enterprise functions. General mandatory training is assessed to have questionable value. Such training is usually not well received, and to be sufficiently accessible it would need to be aimed at such an introductory level that it would not be useful for most individuals with significant duties requiring DE skills.

The costs of training individuals in established occupations can be targeted on the DE skills that augment each individual's base of knowledge and experience. Thus, this approach can be effective if high-quality curricula are available and individuals have effective incentives to succeed with the training.

Education and training costs are largely determined by the extent to which workforce members are compensated for their time. Boot camps are intensive, residential programs and so are relatively costly: the per graduate cost is estimated to range from a low of approximately $18,000 to a high of $32,000. In contrast, reimbursed coursework covering only tuition is relatively inexpensive. For example, the DAWDF provides about $1,500 per year on average in reimbursed training costs for the Defense Acquisition Workforce.

4. Careers, Competencies, and Compensation

The proposals for building civilian careers and competencies fall into three categories: (1) new management and tracking mechanisms (functional career managers, MOSs, new civilian career fields, and credential-based skill tracking); (2) enhanced pay approaches (market-based pay increases for civilians and special pays for military personnel); and (3) targeted career enhancements (expanded public-private exchanges and civilian rotational career paths).

Of these proposals, the compensation options are by far the most expensive, as a pay increase large enough to serve as an incentive would have to be applied across entire categories of the DE workforce. DoD's current pay premiums for technical positions in the AcqDemo program average about 5 percent. Within the military, special pays average

about 9 percent—or about $12,000 to $15,000 per year for a mid-grade individual. However, these alternatives are also likely to be highly effective, as market-based pay has served as an effective incentive to attract talent in both the public and private sectors.

The management and tracking mechanisms as well as the targeted career enhancements show some promise of effectiveness and carry only a low to moderate level of risk. The management and tracking mechanisms are closely related to the enabling measures discussed in Chapter 3 and would be implemented best in conjunction with those proposals. These proposals would not have as great an impact as compensation changes, but would be considerably less expensive since they are limited to the costs of establishing positions to implement and manage the new authorities.

C. Toward an Effective and Efficient DE Workforce Transformation Program

Our analysis describes DoD's ongoing efforts to strengthen the technical workforce and to assess the cost and effectiveness of candidate initiatives. This information should be combined with assessments of DoD's DE skill requirements and further refined to create a strategy for developing a DE workforce improvement strategy.

DoD has several proven building blocks for developing such a strategy. Indeed, extensive authorities are in place and significant efforts are underway that directly or indirectly address the DE workforce. The cost planning factors—while tentative—suggest that important tradeoffs will need to be made in establishing a cost-effective strategy. It is clear that substantial additional analysis and leadership will be required to set requirements and to resource and execute an effective program. As a logical next step, DE skill requirements should be identified, and the information provided through our analysis should be further refined as the basis for an analysis of alternative strategies for strengthening the DE workforce (see Figure 6). The resulting strategy and associated plan will in turn provide the basis for DoD leadership to direct and fund execution of the program.

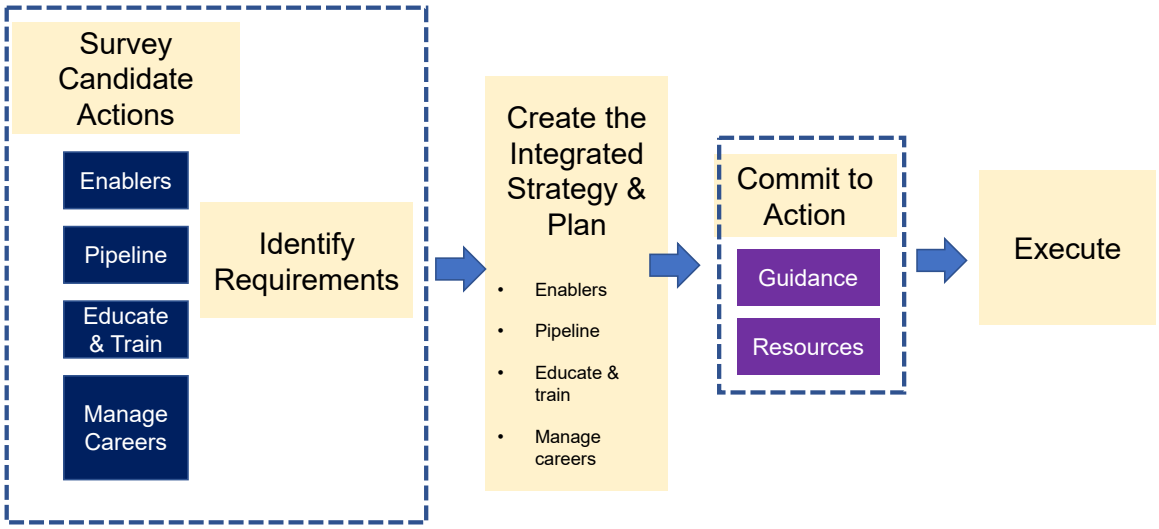

Figure 6. Steps Toward Defining DE Workforce Improvement Initiatives

Appendix A.
Statutes and Proposals
Addressing Critical Skills in DoD

Table A-1. Established Statutory Authorities and Programs

	Authority/Requirement	Citation
Enablers	Zero-Based Review of Cyber and IT personnel	FY 2020 NDAA Sec. 1652
	Senior Military Acquisition Advisors	FY 2017 NDAA Sec. 866
	DIUX Reserve Detachment	10 U.S.C. 2358b (FY 2020 NDAA)
	AI Education Strategy	FY 2020 NDAA Sec. 256
Pipeline	Direct Appointment Authority for Labs	10 U.S.C. 2358a (FY 2017 NDAA)
	Section 219 Defense Labs Hiring Authority	10 U.S.C. 2363 (FY 2009 NDAA)
	Direct Appointment and Enhanced Authority – Cyber	FY 2018 NDAA Sec. 1110
	Direct Hire Recent Grads	FY 2017 NDAA Sec. 1105 and 5 U.S.C. 3115-16
	Direct Hire – Cyber, Acquisition, Science, Tech, Engineering, Mathematics	
	HQEs	5 U.S.C. 9903 (FY 2004 NDAA)
	SMART Scholarship	10 U.S.C. 2192a (FY 2006 NDAA)
	Technology and Natl. Sec. Fellowships	FY 2020 NDAA Sec. 235
	National Security Innovation Ed.	FY 2020 NDAA Sec. 225
	Defense Civilian Training Corps	10 U.S.C. 113 (FY 2020 NDAA)
	Direct Commission to Cyber Positions	FY 2017 NDAA Sec. 509
	Lateral entry/constructive credit for advanced education or experience	10 U.S.C. 533 (FY 2019 NDAA)

	Authority/Requirement	Citation
Education and Training	DAWIA training and certification	10 U.S.C. Ch. 87 (amended by FY 2020 NDAA Sec. 861)
	Civilian Tuition Assistance Program	5 U.S.C. 4107
	Software Training	FY 2020 NDAA Sec. 862
Careers, Competencies, & Compensation	LAB DEMO Pay Banding; Pay Flexibility; Simplified Classification	10 U.S.C. 1599h (FY 1995 NDAA Sec. 342)
	ACQ DEMO Pay Banding; Pay Flexibility; Simplified Classification	FY 1996 NDAA Sec. 4308
	Program Manager Dev. Program	FY 2018 NDAA Sec. 841
	Agile Dev. Training	FY 2018 NDAA Sec. 873(d)
	DCIPS Pay Banding; Pay Flexibility; Simplified Classification	FY 1997 NDAA Sec. 1631-35
	Cyber Workforce Pay Banding; Pay Flexibility; Simplified Classification	FY 2017 NDAA Sec. 1121–22
	Temporary & Term Appointments	FY 2017 NDAA Sec. 1105
	Civilian Rotation Program	10 U.S.C. 1599g (FY 2017 NDAA, amended in FY 2020)
	IT Rotation Program	FY 2010 NDAA Sec. 1110
	Acquisition Exchange Program	FY 2019 NDAA Sec. 884
	Increased Pay Caps (150%) high-level expertise in science, technology, acquisition	FY 2016 NDAA Sec. 1111
	Increased Pay Caps (150%) – Defense Labs	FY 2017 NDAA Sec. 1124
	Digital Talent Management	FY 2020 NDAA Sec. 230
	Special promotion authority for critical skills	10 U.S.C. 605 (FY 2019 NDAA)
	Opt-Out/Career Intermission	10 U.S.C. 619 (FY 2019 NDAA), 10 U.S.C. 710 FY 2019 NDAA)
	Alternative Promotion Authority for Special Categories	10 U.S.C. 649a–649k (FY 2019 NDAA)
	Military and Civilian Cyber Career Paths in the Navy	FY 2020 NDAA Sec. 1653

Table A-2. Recommendations of Commissions and Studies

Defense Innovation Board SWAP		
Enablers	Obtain additional manpower authorizations for military and civilian software developers	Rec. C1.5, S34; Rec. C4.7, S43
	Establish list of skills and experience needed by program office staff for software acquisition	Rec. C3.1, C38
	Modify position descriptions for leaders of software acquisition; programs to prioritize prior software dev. experience	Rec. C3.2, C38
	Evaluate program offices by comparing software skills and experience to model	Rec. C3.5, C38
	Staff and run software offices with presumption of 25% annual turnover	Rec. C4.3, S42; Rec. C4.4, S42
Pipeline	Exercise existing direct hire authority to hire more software developers	Rec. C1.1, S33; Rec. C4.1, C42
	Authorize mid-career onboarding (especially rotations) for experienced civilians	Rec. C1.3, S33
	Expedite interim security clearance process for software developers	Rec. C4.5, S42
Education and Training	Add content on modern software development practices to existing acquisition training	Rec. C2.1, S36
	Establish boot camps and rotations for acquisition professionals	Rec. C2.2, C36; Rec. C3.3, S38
	Train key acquisition leaders on modern software development practices	Rec. C2.3, C36
	Create software continuing education programs and requirements for CIOs, SAEs, PEOs, and PMs	Rec. C2.4, C36
	Modify DAU PM Level IIII training requirements to require hands-on software dev. experience	Rec. C3.4, C38
Careers, Competencies, & Compensation	Create a new MOS for software digital talent	Rec. C1.2, S33
	Create a new civilian occupational code for software digital talent	Rec. C1.2, S33
	Create a mechanism for tracking software development expertise	Rec. C1.4, S34; Rec. C4.2, S42
	Stand up one or more software factories in each Service with military and civilian personnel who develop and deploy software to the field	Rec. C1.6, S34
	Allow rapid promotion of skilled software developers regardless of time-in-grade	Rec. C4.6, S42

National Security Commission on Artificial Intelligence Q1		
Pipeline	Expand Cyber Workforce Authorities to AI	Rec. 1, p. 22
	Greater use of SMEs in hiring process	Rec. 3, p. 25
	Use of ePortfolio reviews in hiring process	HASC 244/Rec. 7, p. 29
	Referral bonuses for hiring software development, data science, and AI experts	Rec. 3, p. 25
	Exemption from OPM GS qualification standards	Rec. 4, p. 26
	Security clearance priority for AI, data science, and software	Rec. 5, p. 27
	Unclassified workspaces for new hires	HASC 243/Rec. 6, p. 28
	Test military and civilian personnel for coding proficiency	Rec. 10, p. 33
	Add computational thinking to ASVAB	Rec. 11, p. 34
	Hire STEM professors/students as part-time government researchers	SASC 216/HASC 246/NSCAI Rec. 12, p. 36
	Increase use of Pathways internships for STEM in national security	Rec. 13, p. 38
	Expand CyberCorps: Scholarship for Service (C:SFS) to cover entire digital workforce	Rec. 14, p. 39
	Establish Civilian ROTC to feed Digital Corps	Rec. 1, p. 35
	Expand SMART scholarships and C:SFS	Rec. 2, p. 42
	Create a United States Digital Service Academy	Rec. 3, p. 43
Education and Training	AI literacy for HR teams	HASC 242/NSCAI Rec. 2, p. 24
	Special hiring and training for HR teams	HASC 242/NSCAI Rec. 2, p. 24
	Mandatory AI training for entire DoD workforce	Rec. 8, p. 30
	Certified self-development in AI	HASC 245/Rec. 9, p. 31
Careers, Competencies, & Compensation	Increase use of industry exchange programs	HASC 249/NSCAI rec.
	Create a Civilian National Reserve Digital Corps	Rec. 1, p. 35

National Commission on Military, National, and Public Service		
Enablers	Increase agency emphasis on human resource planning and talent management: develop workforce plans	Rec. 25, p. 78
Pipeline	Increase public awareness of military careers - increase public access to bases, military access to schools	Rec. 9a, p. 34
	Partnerships for Guard and Reserve units with schools and community service orgs	Rec. 9b, p. 35
	Increase JROTC, utilize Starbase, Youth ChalleNGe, cadet corps, other partnerships	Rec. 10a, p. 36
	Promote ASVAB CEP in schools	Rec. 10b p. 37
	Provide tuition grants for pre-service professional degrees, certificates	Rec. 12a., p. 39
	Expand access to Cyber Leadership Development Program in ROTC	Rec. 12b, p. 40
	Expand funding for Cyber Institutes established in FY 2019 NDAA	Rec. 12b, p. 40
	Improve USAJOBS, make it interoperable with third-party job boards, accept standard resumes	Rec. 21a, p. 68
	Use hiring managers and SMEs for recruitment and hiring vs. keyword-based reviews and self-assessments	Rec. 21b, p. 68
	Promote and facilitate the use of non-competitive hiring authorities	Rec. 22, p. 70
	Modify veterans' preference to a tie-breaker for new employment	Rec. 23a, p. 71
	Authorize non-competitive hiring after internships, scholarships, and fellowships	Rec. 23b, p. 72
	Focus direct hiring of students and recent grads on critical skill areas; lift cap on usage	Rec. 24b, 24d, p. 75
	Establish a separate track of the PMF program for fellows with a technical focus	Rec. 24f, p. 76
	Establish a civilian public service corps similar to the ROTC; bring a cohort of public service cadets into military academies	Rec. 24g, p. 76
	Provide funding for institutions of higher learning to establish public service academies	Rec. 24h, p. 77
Education and Training	Prioritize tuition assistance for critical skills	Rec. 12a., p. 39

Careers, Competencies, & Compensation	Develop focused personnel management structure for recruiting and retaining specific military skills such as cyber and engineering	Rec. 13a, p. 42
	Use warrant officer positions to ease transitions, increase permeability	Rec. 13a, p. 42
	Establish permanent billets (vs. temporary) in DDS and similar entities	Rec. 13a, p. 42
	Use more flexible, rank-list promotion method	Rec. 21c, p. 69
	Pilot a federal civilian cybersecurity reserve program	Rec. 27d, p. 81
Section 809		
Pipeline	Consolidate direct hiring authorities, expand to cover all critical skills deficiencies, and remove limitations	Rec. 25, p. 77
Education and Training	Amend DAWIA to implement third-party certification and training; eliminate education requirements	Rec. 59, p. 284
Careers, Competencies, & Compensation	Make AcqDemo permanent; expand to all acquisition workforce positions	Rec. 26, p. 86
	Require DoD to develop career paths for all acquisition career fields; establish competency model with proficiency standards vs. training requirements	Rec. 60, p. 303
DSB Software Acquisition Report		
Enablers	Embed cadre of software systems architects and developers in service acquisition commands	Rec. 5, p. 26
	Develop a software workforce fund modeled on DAWDF	Rec. 5, p. 26
Education and Training	DAU should develop curriculum on modern software practices for PMs of software-intensive programs	Rec. 5, p. 26
Cyberspace Solarium Commission Report		
Enablers	Fund research on cybersecurity workforce	Rec. 1.5, p. 43
Pipeline	Use apprenticeships and cooperative study as recruiting tools	Rec. 1.5, p. 43
	Fund recruiting programs specifically designed to target cyber talent	Rec. 1.5, p. 44
	Expand CyberCorps: Scholarship for Service program from 200 students/year to 2,000 students/year	Rec. 1.5, p. 44
	Improve cyber-oriented education for K-12 and in colleges and universities	Rec. 1.5.1, p. 45

Careers, Competencies, Compensation	Develop competency measures in addition to commonly-used certifications	Rec. 1.5, p. 43
	Design cyber-security specific upskilling and transition assistance programs for veterans to move service members into civilian workforce	Rec. 1.5, p. 44
	Develop a new Civil Service Cyber with competence-based metrics for government-wide cyber-specific career paths	Rec. 1.5, p. 44
	Expand the DHS Cyber Talent Management System (CTMS) government-wide	Rec. 1.5, p. 44
Force of the Future		
Pipeline	Enhance college internship programs	http://www.ssri-j.com/MediaReport/DocumentUS/FactSheetBuildingTheFirstLinkToTheForceOfTheFuture.pdf
	Designate Chief Recruiting Officer	
Careers, Competencies, & Compensation	Launch entrepreneur-in-residence program	
	Expand public-private rotation programs	
	Increase size of career intermission program	
	Implement web-based talent management system for military services	
	Establish talent-management centers of excellence to provide data and modeling	
	Establish Center for Talent Development to provide guidance on civilian careers and opportunities	
NAPA – No Time to Wait2		
Pipeline	Hire "talent pools" (instead of position-based hiring)	p. 20, 29
Careers, Competencies, & Compensation	Use talent managers who can assign employees with critical skills to specific projects and tasks (instead of position-based assignments)	p. 19
	Use cadres of experts (including temporary and term employees) to address high-priority problems	p. 20
	Establish special occupational pay systems in lieu of GS positions and classifications	p. 42

PFP – Mobilizing Tech Talent		
Pipeline	Engage in active recruiting for critical skills (vs. posting and waiting)	p. 17
	Engage in rigorous technical evaluation rather than accept minimum qualifications	p. 17
	Use Schedule A authority for quick hiring of highly skilled, limited-term employees	p. 19
	Create digital fellowships for college students	p. 27
	Offer continuity of service through mechanisms like bug bounties and 2-week discovery sprints, exposing more people to govt. opportunities	p. 27
	Bring tech teams to where the talent is - Silicon Valley, Austin, etc.	p. 27
	Challenge companies to establish "civic leave policies" - sabbaticals to do government service	p. 27
	Establish Center for Talent Development to provide guidance on civilian careers and opportunities	
Reports		
Enablers	Identify who is in the software acquisition workforce	Sean Robson, Bonnie Triezenberg, Samanth DiNicola, Lindsey Polley, John Davis, and Maria Lytell, Software Acquisition Workforce Initiative for the Department of Defense: Initial Competency Development and Preparation for Validation, RAND RR-3145-OSD, 2020
	Validate Software Acquisition competencies	
Pipeline	Use low-interest loans, subsidies, scholarships, and loan forgiveness to encourage software education in exchange for service obligation	19-838 – Tate Software Productivity, Defense ARJ, April 2020, Vol. 27 No. 2: o, 157
	Relax barriers to hiring foreign nationals	
	Cohort hiring	https://warontherocks.com/2019/05/building-a-21st-century-defense-acquisitionworkforce/
	Signing bonuses for individuals with critical skills	Levine – NSPS (IDA Paper NS P-8586), p. 107
	Structured internship programs to recruit individuals with critical skills	
	Use HQEs, IPAs, and temporary hires to fill skills gaps	

Careers, Competencies, & Compensation	Establish long-term career management for acquisition civilians	IDA Paper P-10785 – Adaptability of US Navy RDA, Rec. 2, p. 4-9
	Designation of rotational positions for career development	https://warontherocks.com/2019/05/building-a-21st-century-defense-acquisitionworkforce/
	Use of functional career managers to administer career development	
	SecDef authority to establish defense-unique occupational classifications w/higher grades for high-demand skills	Levine – NSPS (IDA Paper NS P-8586), p. 107–112
	SecDef authority to grant grade increase for exceptionally high-performing individuals	
	Reinstitute 4- or 5-rating performance management system	
	Performance-based step increases for personnel with critical skills	
	Authorize SecDef to provide market-based pay adjustments for critical career groups and occupations	
	Authorize special pays for civilians with critical skills	
	Raise pay caps for employees with critical skills	
	Significantly increase bonus pool for employees with critical skills	
	Review employee performance prior to end of probation period	
	Establish dedicated performance improvement managers	
	Designate functional career advocates to develop career development plans for employees with critical skills	

Pena – Tour of Duty Hiring – IDA Paper NS D-10700		
Pipeline	Use temporary hiring authorities such as IPAs, Direct Hire Authority, Schedule A, and Expert and Consultant Pay to bring in tech talent for term appointments.	p. 3
	Use internships/fellowships, associateship programs, industry exchange programs, and residency programs to bring in outside expertise	p. 7, 16
	Engage in active, strategic recruiting for critical skill positions	p. 13-14
	Build a highly qualified recruiting team	p. 14
Workshop on Scholarship-for-Service Programs, IDA Paper NS D-9028		
Pipeline	Supplement internships and fellowships by assigning mentors	p. 2
	Enhance internships and fellowships by establishing alumni groups	p. 4, 7
	Build continuing relationships with academic institutions to develop pipelines for fellowships and scholarships	p. 5
	Target STEM scholars by attending conferences, visiting academic institutions, and participating in professional societies and associations	p. 8

Appendix B.
Cost Methodology, Data Sources, and Summary of the Major Cost Findings

Cost Planning Factors: Assumptions and Sources

The IDA team developed rough approximations of costs for each of the 24 proposals in our analysis. The assessments consider both the up-front costs of initial implementation and the recurring costs of sustaining the proposals over time. The data used for estimating costs vary substantially across the proposals. In many cases, the cost estimates could draw on previous experience or similar activities; in a few cases, costs are based on deductive modeling. Because of data limitations, the need for a DE workforce requirements analysis, and the necessarily broad definitions of the proposals, the cost information is presented as cost planning factors rather than budget-quality cost estimates. Although these planning factors are only approximations, they provide a starting point to inform decisions regarding an affordable scope and structure for a DE strategy.

This appendix contains a summary of the assumptions and data sources underlying the planning factors.[1]

Administrative Costs Assume a Federated Management Structure

Although most of the proposals have specific, identifiable cost elements, several also have substantial, common administrative, analytical, or information technology cost elements. To establish cost planning factors, these common costs are allocated to one of the three classes of management organizations included in the proposals: an OSD management activity, a collection of DE functional career management organizations, or DE recruiting organizations. In order to sort out these costs and provide cost planning factors, it is assumed that a federated management structure is established, and administrative duties are allocated among the three classes of organizations as follows:

- OSD Management Activity: Provides leadership, metrics and analysis, information technology, and administration for proposals with DoD-wide scope.

[1] We use OSD-CAPE's Full Cost of Manpower (FCoM) tool to determine the cost of personnel. FCoM is maintained by CAPE and estimates the full cost for having civilians, military personnel, and contractors work for the government based on many variables, including grade, location, and special pays. The tool is accessible to anyone with a DoD common access card at https://fcom.cape.osd.mil/.

This activity would conduct Proposals 1 through 4 and have management responsibilities connected to several more, including 10, 12, 18, 19, 22, and 23.

- Functional Career Management Organizations: Provide leadership, metrics and analysis, information technology, and administration for proposals that will be tailored by each Service. These include responsibility for the management and administration of Proposals 5, 6, 9, 11, 14, 15, 17, 18, 20, 21, and 24.
- Recruiting Offices: Provide focus for establishing innovative hiring authorities and practices to compete in the DE marketplace. This addresses responsibility for Proposals 7 and 8.
- Unassigned: Two of the examined proposals were found to be ineffective, and therefore are not assigned (Proposals 13 and 16).

The cost planning factors for the OSD management activity, the functional career management offices, and the DE recruiting offices are derived assuming this federated structure and assignment of responsibilities.

Summary of Cost Planning Factors

Table B-1 presents the cost planning factors using the federated administrative structure described previously. The top of the table shows the costs associated with the three organizational components of the federated management structure: (1) OSD management activity, which includes the seven proposals whose costs are fully assigned to that activity; (2) Functional Community Managers; and (3) DE recruiting activities. Each of these components will have specific assigned tasks, including administrative responsibilities for the various programmatic activities.

Costs are assigned based on the expected scale of each organization, plus funding for analytical activities, outreach, and other mission support.

The essential and major startup activity for the OSD management activity is the initial DE workforce requirements analysis. This analysis provides the information needed to design and target virtually all of the proposals. In particular, the requirements analysis includes the work necessary for defining the military occupational specialties, the civilian career fields, and the system for credential-based skills tracking.

The fourth block in the table provides the cost factors for the programmatic proposals. Nearly all of the costs identified in these programmatic proposals fall into five categories and are expressed on a per-person basis:

- Scholarships to students – in return for service obligations
- Market-based and special pays for the DE workforce
- Pay for temporary or term employment of specialized DE experts

- Workforce education and training
- Transfer and logistics costs associated with exchange or rotation programs

The startup costs associated with the programmatic proposals cover the institutional costs associated with establishing new outreach or educational programs. Establishing a new ROTC program or academy for civilians entail major institution-building costs that are not a part of any of the other proposals. These costs call the cost efficiency of these proposals into question. The startup costs associated with the digital boot camps would apply in cases where a new curriculum is created to tailor courses to DoD.

Table B-1. Cost Planning Factors

Proposal	Startup Activity Costs (000s)	Annual Per-Person Cost (000s)	Annual Fixed Cost (000s)
OSD Management Activity			
1 Requirements analysis	$10,000		$8,000–$10,000
2 DE manpower management			
3 Workforce metrics & tracking			
4 Resource management			
19 Define new civilian career fields			
18 Define new military occupational specialties for software			
23 Credential-based skills tracking			
Functional Community Managers			
17 Functional Career Managers (Army, Navy, USAF, Marines, Space, 4th Estate)			$18,000
DE Recruiting Offices			
7 STEM civilian recruiting offices (Eastern, Central, Western)			$54,000
8 Digital force recruiting units for uniformed services (Army, Navy, USAF, Marines, Space)			$54,000

Proposal	Startup Activity Costs (000s)	Annual Per-Person Cost (000s)	Annual Fixed Cost (000s)
Programmatic Proposals			
5 Hire STEM professors & students for summer breaks		$30–$100	
6 & 11 Provide fellowships w/stipends & summer employment		$50–$70	
9 Cohort hiring		$18–$36	
10 Rotational cadres of digital experts		$150–$500	
Expanded SMART scholarships and C:SFS		$50–$70	
12 Defense Civilian Training Corps	$60,000	$50–$70	
13 Digital Service Academy for Civilians	$800,000	$250	
14 Digital boot camps for upskilling military & civilian employees	$250–$1,300	$20–$30	
15 DoD reimbursed coursework		$0–$8	
16 Mandatory digital training for all DoD employees		$0.05	
20 Market-based pay for DE civilians		$5–$10	
21 Special pays for DE military		$9–$15	
22 Expanded public-private exchange		$15–$20	
24 Civilian rotational career paths		$5–$10	

Cost Parameter Assumptions and Sources for All Proposals

OSD Management Activity (Proposals 1, 2, 3, 4)

This proposal would establish the OSD-level activity responsible for providing DoD-wide integration and coordination of the DE workforce improvement initiatives. As described earlier, this activity would head a federated structure that will provide administrative, analytical, and information technology support across the proposed DE workforce initiatives. This activity would also manage Proposals 18, 19, and 23.

Assumptions: The responsibilities of this OSD-level activity are parallel to those of the Human Capital Initiatives (HCI) organization in OUSD(A&S) for the acquisition workforce. Thus, we use HCI as the model and assume the funding required for the DE management organization will approximately equal the costs of the HCI management structure. The planning factor for costs includes the staff for administering programs, analytical and data capabilities, and information technology costs.

Cost Planning Factor: The initial DE workforce requirements study (Proposal 1) will establish needed workforce knowledge, skills, and experience (KSEs) that will provide the basis for defining DE occupations and credentials. This effort will entail an extensive survey across DoD components at an assumed cost of **$10 million**. We further assume the OSD management activity will require roughly 40 FTE staff-years of effort plus IT support to sustain; we estimate a cost planning factor of **$8 to $10 million**.

Sources: DoD, 2020 DAWDF Annual Report; DHS, Cybersecurity and Infrastructure Security Agency budget justification.

University Faculty and Student Summer Programs (Proposal 5)

This proposal provides summer programs in which university faculty and students work on specific projects or problems.

Assumptions: The program provides competitive compensation plus expenses for all participants. The costs will roughly parallel the existing SCAMP program sponsored by NSA.

Cost Planning Factors: **$30,000** for students and **$100,000** for senior faculty participants per year.

Source: Interviews with NSA SCAMP program administrators and program accounting data.

Fellowships with Stipends and Employment (Proposal 6)

The cost of paying for a student's education is the cost of this proposal as well as Proposal 11 and a significant component of Proposal 12; therefore, three outreach programs are included: two scholarship-for-service programs and one civilian, ROTC-like program.

Assumptions: Each outreach program will subsidize educational costs or pay education costs plus a stipend. The costs are assumed to be quite similar to those of the existing SMART Program.

Cost Planning Factors: **$50,000–$70,000** per student per year of participation.

Sources: James Belanich et al., *Science, Mathematics & Research for Transformation (SMART) Outcome Evaluation Report*, IDA Document D-9262 (Alexandria, VA: Institute for Defense Analyses, September 2018); OUSD(A&S) and OUSD (P&R), *Establishment of Defense Civilian Training Corps: Initial Implementation Plan,* August 2020.

Civilian Digital Engineering Recruiting Offices: East, Central, and West Regions (Proposal 7)

The DE offices will work in concert with established recruiting activities to bring added focus to DE talent requirements. In addition, these offices will provide recruiting resources and approaches tailored to the DE workforce.

Assumptions: The level of effort for civilian recruiting activities will roughly parallel DoD's recruiting efforts for medical personnel. The Army medical recruiting organization (15 officers and 62 enlisted) provides the model. In addition, we assume each office will have a budget of $6 million for outreach activities and branding.

Cost Planning Factor: Given the level of staffing described previously, the estimated staff costs for each civilian DE recruiting office would equal $12 million. To this we added an allocation of $6 million annually for each office. Thus, the cost for three offices would total **$54 million**.

Source: Army medical recruiting brigade data.

Military Digital Engineering Recruiting Offices: Army, Navy, USAF, Marines, Space (Proposal 8)

The DE recruiting offices will work in concert with established recruiting activities to bring added focus to DE talent requirements and provide recruiting resources, authorities, and expertise tailored to the DE workforce.

Assumptions: The military digital recruiting offices will be small, approximately 20 personnel each. They will provide advice, access to resources, and generally act in collaboration with established recruiting organizations. Each office will have $6 million for outreach and branding activities.

Cost Planning Factor: 20-person offices with mixed grades ($3 million) and resources ($6 million) for each Service. A total allotment of $9 million per office, which totals **$54 million** for all five Services.

Source: Recruiting recommendations of the National Security Commission on Artificial Intelligence (NSCAI), *Interim Report and Third Quarter Recommendations*, October 2020, 97.

Cohort Hiring (Proposal 9)

Cohort hiring is an approach under which the Department brings on large groups of entry-level new hires for a specific career track at the same time. Best-in-kind cohort hiring programs put new recruits through common training and rotational programs to build foundational knowledge and expertise, group cohesion, and commitment to the mission.

Assumptions: IDA assumes a three-month training and rotation program for cohort hires, in addition to any training that other new hires receive. Following this training, we assume the new hires transition to established billets; therefore, no additional compensation costs are included in the proposal. Administrative duties for managing cohort programs are performed by the Functional Career Management Offices of the Services and Fourth Estate; those costs are included in Proposal 17.

Cost Planning Factor: New cohort hires would be provided three months of pay and training upon entry, and then transition to their initial assignments. We postulate that the cost of this would equal the costs of DoD boot camps discussed under Proposal 14. Thus, the estimated cost would range between approximately **$18,000 and $36,000** for each new government employee brought in through the cohort hiring mechanism.

Source: See Proposal 14.

Rotational Cadres of Digital Experts (Proposal 10)

This proposal would establish a cadre of industry or academic digital experts serving short-term rotational or episodic tours of duty to address specific challenges within the Department.

Assumptions: We assume that the compensation for the rotational cadres is provided through a central fund. These compensation costs are the primary cost of this proposal. To gauge personnel costs, we assume levels of expertise and experience, and thus compensation, similar to the top experts participating in the summer program outlined in Proposal 5. It is assumed that the rotational cadres would be managed through OSD.

Cost Planning Factors: The annual cost per expert would range from **$150,000** for junior staff to **$500,000** for very senior experts. Administrative duties would be assigned to the OSD management activity; those costs are captured there.

Source: Cost data for the NSA SCAMP program (see Proposal 5).

Expanded Use of Scholarship-for-Service Programs (Proposal 11)

For this proposal, we use the same costing assumptions, factors, and sources as for Proposal 6.

Defense Civilian Training Corps: An ROTC-Like Program for Civilians (Proposal 12)

This proposal would create a civilian scholarship program built around ROTC-like units that would enhance not only digital expertise, but also unit cohesion and alignment with DoD's mission.

Assumptions: Each member will receive educational costs plus a stipend for each year of participation. In addition, similar to ROTC units, each location will require leadership, administration, and a physical footprint.

Cost Planning Factors: **$50,000–$70,000 per student** per year of participation. There are additional start-up costs and ongoing costs associated with the on-campus presence and administration of the program, which is estimated at roughly **$60 million**.

Source: OUSD(A&S) and OUSD (P&R), *Establishment of Defense Civilian Training Corps: Initial Implementation Plan,* August 2020.

Digital Service Academy for Civilians (Proposal 13)

This proposal would establish a four-year degree institution parallel to the Service Academies or the Uniformed Services University of the Health Sciences (USUHS). Students would have a post-graduation service requirement.

Assumptions: The costs of the Digital Service Academy would be comparable to the costs of established DoD four-year educational institutions. Available data for the USUHS can be used to establish cost planning factors.

Cost Planning Factors: Annual cost per student: **$250,000**; startup costs: **$800 million**.

Source: Sarah John et al., *Analysis of DoD Accession Alternatives for Military Physicians: Readiness Value and Cost*, IDA Paper P-10815 (Alexandria, VA: Institute for Defense Analyses, November 2019).

Boot Camps—Intensive Residential Training Programs (Proposal 14)

Boot camps provide intensive residential training that targets specific skills. A typical boot camp program lasts 6 to 10 weeks, training a cohort of 10 to 30 students in interactive teams, with the intent of instilling a useful set of entry-level skills at the end of that period.

Assumptions: Costs include instructor wages, student wages for time spent in the course, student travel expenses, and the cost of operating a computer-enabled classroom facility to accommodate the projected number of students. Costs vary substantially depending on whether the program leverages existing commercial boot camps versus creates DoD-unique programs, the level of instruction and length of training, and size of training cohorts.

Cost Planning Factors: The per-graduate cost planning factor ranges from a low of approximately **$19,000** for a custom DoD introductory curriculum to a high of **$55,000** for an intensive, advanced curriculum offered commercially. Estimates for the fixed cost of establishing a custom DoD course range from a low of approximately **$220,000** to a high of **$1.05 million** for extensive, complex courses.

Sources: IDA cost modeling is based on numerous sources: Robyn A. Defelice, "How Long to Develop One Hour of Training: A Case Study," February 2019, Association for Talent

Development, https://www.td.org/insights/how-long-to-develop-one-hour-of-training-a-case-study; Salary.com; Deborah Keyek-Franssen et al., "Computing Labs Study University of Colorado Boulder Office of Information Technology," October 7, 2011, OIT CU-Boulder, https://oit.colorado.edu/sites/default/files/LabsStudy-penultimate-10-07-11.pdf; Rick Petersen, "At What Cost Classrooms? The Experience of One Institution," UNC-Chapel Hill, https://slideplayer.com/slide/5902686/, from ~2008–2009; Council on Integrity in Results Reporting (CIRR), July–December 2019 Graduate Outcomes, https://cirr.org/data.

Reimbursed, Self-Initiated Individual Training (Proposal 15)

This proposal would reimburse tuition expenses for individuals who complete instruction in approved DE courses.

Assumptions: DoD employees have access to a broad range of self-initiated DE education and training. Reimbursed training includes tuition payments for in-person or online courses. It does not include compensation for the DoD employees taking the courses. Estimates of the cost to deliver the course for one year are a combination of course fees and student wages for time spent in the course. Estimates of the range of course fees are based upon fees currently charged by various providers offering similar courses, from more elementary syllabi to more comprehensive, accelerated degree programs.

Cost Planning Factors: The bulk of the costs are in course fees. The resulting per-graduate costs for the first year of the commercially available online certification option are estimated to range from less than **$100** to a high of **$8,700**. In 2019, DoD spent an average of **$1,521** dollars on education and training for each member of the acquisition workforce.

Sources: Sources for the IDA modeling included LinkedIn Learning, Udemy, ITPro.com, Boston College Global Leadership Institute, and Western Governor's University, among others. Completion rates are from the CIRR. DoD average training expenditures for the acquisition workforce is calculated from DoD's 2020 DAWDF Annual Report.

Mandatory Universal Training (Proposal 16)

DoD requires mandatory training for many compliance-oriented requirements in areas such as security and personnel management. This proposal would add a training requirement to increase awareness and knowledge of DE competencies that would raise the overall level of DoD's DE expertise.

Assumptions: The dominant cost of universal training is the opportunity cost of the time of the participants taking the course. DoD's workforce totals approximately 3 million, so each hour of coursework would cost 3 million hours of workforce time. IDA modeled the cost of the program by estimating development costs for a 1- to 3-hour, fully remote, online

digital literacy course customized for DoD combined with the cost of participant time spent for one year of operation. All students are assumed to complete the course.

Cost Planning Factors: A median hourly DoD wage of **$34.48** for students was used. Resulting cost estimates for the first year range from a low of approximately **$103 million** to a high of approximately **$310 million**. Almost all costs are from student wages, with only a small fraction attributable to course development.

Sources: Association for Talent Development; Salary.com; DMDC Appropriated Fund (APF) Civilian Master File.

Functional Career Management Offices: Army, Navy, USAF, Marines, Space, Fourth Estate (Proposal 17)

This proposal would establish functional career managers within the Department for some or all DE career fields. These offices would be responsible for managing the integrated execution, oversight, and resourcing of acquisition education, training, and talent management for both uniformed and civilian acquisition workforce personnel in their department.

Assumptions: The closest parallels to the proposed functional career managers are the Defense Acquisition Career Management organizations (DACMs). DACMs provide career management services and track workforce trends across 15 acquisition-related career fields. They also coordinate with the OUSD(A&S) HCI office. It is assumed the staff requirements for the Functional Career Management Offices would be roughly the same as for the DACMs.

Cost Planning Factor: The annual budget for CISA training and workforce development activities was about **$3 million**. The total DoD-wide cost planning factor is then **$18 million.**

Source: Costs for DACMs are provided in DoD budget justification documents.

New Military Software Occupational Specialty (Proposal 18)

This proposal would establish an MOS specifically for software developers in each military department, with (potentially Service-specific) subcategories aligned with both current and desired future software development roles within those Services.

Assumptions: The costs associated with creating a new occupational specialty include the administrative costs of defining the occupation, identifying needed attributes, and designating the membership. The initial work to identify and define needed new career fields would be accomplished through the initial requirements analysis outlined in Proposal 1. The Functional Career Management organization would be responsible for ongoing management.

Cost Planning Factor: The task of establishing and managing new DE occupational specialties will be assigned to each Functional Career Management organization. Therefore, the cost is attributable to the Functional Career Management organizations (Proposal 17).

New Civilian Career Fields (Proposal 19)

This proposal would revise and expand position classification standards to include new occupational series for distinguishable jobs and careers related to software development, data science, and other DE professions.

Assumptions: The initial work to identify and define needed new career fields would be accomplished through the initial requirements analysis outlined in Proposal 1. These include the costs of identifying needed attributes, designating the membership, and establishing associated data and information technology support. The OSD management activity would be responsible for ongoing management.

Cost Planning Factor: See the costing assumptions, factors, and sources for the OSD management activity.

Source: See the costing assumptions, factors, and sources for the OSD management activity.

Market-Based Pay for DE Civilians (Proposal 20)

This proposal would extend DoD's existing flexible pay authority to the DE workforce. Such pay systems are already in place for many hard-to-fill civilian occupations, including lawyers, acquisition personnel, STEM personnel in laboratories, and medical professionals.

Assumptions: The cost of this proposal should be measured by the incremental pay increases resulting from extending market-based pay to segments of the DE workforce that are not yet covered through acquisition, laboratory, or other flexible pay plans. To make this calculation, it is assumed that comparing observed current pay under the GS system with pay for a similar job under the flexible AcqDemo system provides a reasonable indicator of the average wage increase that would result from moving individuals under a market-based pay system.

Cost Planning Factors: The average observed pay differential between GS and AcqDemo is **4.9 percent.** This translates to a pay differential of **$5,000** to **$10,000** for DoD civilians.

Source: IDA modeling based on the DMDC's DoD Personnel Master File.

Special Pays for DE Military Specialties (Proposal 21)

This proposal would extend special pays for DE military occupations similar to those already in place for a number of high-demand military specialties. Special pays allow the military components to offer competitive compensation and to adjust offers in adapting to changing labor market conditions.

Assumptions: There is tremendous variability in special pays across military specialties, ranging from nothing, to $12,000, to over $50,000 per year. The design of a special pay system for DE skills will require the analysis of U.S. labor market conditions and internal DoD workforce conditions and trends. To provide a planning cost factor, we assume the average special pay for DE personnel will equal DoD's overall average as a percentage of compensation.

Cost Planning Factors: In aggregate, DoD's special and incentive pays amount to $7.7 billion, which is just under **9 percent** of total current cash compensation. This translates into a pay premium of **$9,000** to **$15,000** per year for the most relevant pay grades.

Sources: DMDC's DoD Personnel Master File; Department of Defense, Militarypay.defense.gov; "Title 37, Chapter 5, Subchapter I – S&I Pays Currently for Active Duty Service Members."

Expanded Public-Private Exchange (Proposal 22)

This proposal would expand authorities to conduct public-private exchange programs (PPEPs) to a significantly larger number of participants and relax existing restrictions and constraints on the use of exchange mechanisms. Under this proposal, civilians would rotate from government to private industry and back (or vice versa) for a temporary detail of defined duration and scope.

Assumptions: This proposal is not designed to expand the DoD workforce, but rather to provide a mechanism to foster a freer flow of personnel. The major cost drivers, therefore, are assumed to be the administrative costs of managing the program, the reimbursement of costs associated with the movement of individuals in and out of the government, and any productive time lost during the process of transferring.

Cost Planning Factors: A comparable AAAS program with about 250 fellows is managed by 21 people. A 20-person staff would require approximately **$3 million**. The transfer cost per participant is assumed to be on the order of **$15,000 to $20,000**. For example, these costs account for about $5,000 for relocation and about $5,000 for two weeks of lost productivity, each of which occurs at both the beginning and end of each exchange. The OSD management activity would administer the program and thus would incur those costs.

Sources: AAAS Fellowship Program; David Graham et al., *The Defense Personal Property Program: Organizing to Better Serve Military Members*, IDA Paper P-9078, April, 2018.

Credential-Based Career Tracking (Proposal 23)

This proposal would implement skill-based tracking of worker competencies as defined credentials applicable to a variety of careers and work roles. This proposal enables and closely complements the top-level OSD management organization's activities, as well as the Functional Career Management activities described earlier.

Assumptions: The initial work to identify and define needed DE credentials would be accomplished through the initial requirements analysis outlined in Proposal 1. These include the costs of identifying needed KSEs, designating the association of these skills and attributes with billets and personnel classes, and establishing associated data and information technology support. The OSD management activity would be responsible for ongoing management.

Cost Planning Factor: See the costing assumptions, factors, and sources for the OSD management activity.

Source: See the costing assumptions, factors, and sources for the OSD management activity.

Civilian Rotational Career Paths (Proposal 24)

This proposal would provide a mechanism for building civilian careers by developing a set of limited-tenure positions that would be available to employees opting for a career-building track. Employees would be assigned to these positions to acquire needed skills and then move on to new assignments without giving up their employment status. Special periods for training and education could be built into the career-building rotation system.

Assumptions: Creating these rotational billets does not add employees to the Department or require a large bureaucracy. Rather, functional career managers and line managers would manage these billets within the Department. The principal costs would be the lost productivity during job transitions and a few weeks of additional training and education for every year that an employee remains in a rotational career program.

Cost Planning Factor: We assume a total of two weeks per year of participants' time is spent in training or is lost during transfers between developmental assignments. This assumption yields a cost factor of about **5 percent** of employee wages. This equals **$5,000** to **$10,000** for the most common pay ranges. Administrative responsibilities and costs are assigned to the Functional Career Management organizations (Proposal 17).

Source: IDA modeling.

Illustrations

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Abbreviations

AAAS	American Association for the Advancement of Science
AcqDemo	Acquisition Demonstration Program
AEOP	Army Education Outreach Program
AFSC	Air Force Specialty Code
AI	Artificial Intelligence
ASVAB	Armed Forces Vocational Aptitude Battery
BLS	Bureau of Labor Statistics
CAPE	Cost Assessment and Program Evaluation
CIRR	Council on Integrity in Results Reporting
C:SFS	Cyber: Scholarships for Service
DACM	Director for Acquisition Career Management
DARPA	Defense Advanced Research Projects Agency
DAU	Defense Acquisition University
DAWIA	Defense Acquisition Workforce Improvement Act
DAWDF	Defense Acquisition Workforce Development Fund
DCIPS	Defense Civilian Intelligence Personnel System
DCTC	Defense Civilian Training Corps
DE	Digital Engineering
DIB	Defense Innovation Board
DoD	Department of Defense
EDPT	Electronic Data Processing Test
FA	Functional Area
FCoM	Full Cost of Manpower
FFRDC	Federally Funded Research and Development Center
GAO	U.S. General Accounting Office
GS	General Schedule (for government pay)
HCI	Human Capital Initiative
IDA	Institute for Defense Analyses
IPA	Intergovernmental Personnel Act
KSE	Knowledge, Skills, and Experience
LabDemo	Laboratory Demonstration program

MOOC	Massive Open Online Course
MOS	Military Operational Specialty
NAPA	National Academy of Public Administration
NDAA	National Defense Authorization Act
NDSEG	National Defense Science and Engineering Graduate fellowship
NICCS	National Initiative for Cybersecurity Careers and Studies
NICE	National Institute for Cyber Education
NIST	National Institute for Science and Technology
NMS	National Military Strategy
NRDC	National Reserve Digital Corps
NRL	Naval Research Laboratory
NSCAI	National Security Commission on Artificial Intelligence
O*NET	Occupation Network – Department of Labor sponsored on-line occupational data
ORSA	Operations Research and Systems Analysis
OSD	Office of the Secretary of Defense
OUSD(A&S)	Office of the Under Secretary of Defense for Acquisition & Sustainment
OUSD(P&R)	Office of the Under Secretary of Defense for Personnel & Readiness
PCS	Position Classification Standard
PPEP	Public-Private Exchange Program
QRMC	Quadrennial Review of Military Compensation
ROTC	Reserve Officers' Training Corps
S&I	Special and Incentive [pay]
SCAMP	Special Conference on Applied Mathematical Problems
SES	Senior Executive Service
SMART	Science, Mathematics & Research for Transformation
SME	Subject Matter Expert
SOC	Standard Occupational Classification
STEM	Science, Technology, Engineering, Mathematics
STRL	Science and Technology Reinvention Laboratory
SWAP	Software Workforce Acquisition and Practices
TTHS	Trainees, Transients, Holdees, and Students
USD	Under Secretary of Defense
USDSA	United States Digital Service Academy
USUHS	Uniformed Services University of the Health Sciences

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14. ABSTRACT

The IDA team addressed a Congressional requirement to document the costs and benefits of options for strengthening the DoD "digital engineering" (DE) workforce. Our analysis covered a broad range of DE skills, as defined by Congress, in both the military and civilian workforces. The IDA team surveyed previous and ongoing initiatives and proposals to improve the workforce and organized these efforts into four areas: (1) necessary enabling measures (establishment of requirements, metrics, resources, and organizations); (2) pipeline programs for new talent; (3) education and training programs; and (4) programs and structures for managing careers, competencies, and compensation. We then selected 24 candidate initiatives for in-depth analysis of their effectiveness, risk, and costs. Our assessment identifies promising building blocks for a DE workforce improvement strategy and describes the steps for creating a cost-effective DE workforce program.

15. SUBJECT TERMS

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