REPORT TO CONGRESS ON
FY20 NDAA SECTION 862(b)(1)(B)
SOFTWARE DEVELOPMENT AND SOFTWARE ACQUISITION TRAINING AND MANAGEMENT PROGRAMS

Office of the Under Secretary of Defense
for Acquisition and Sustainment

January 2021

The estimated cost of this report or study for the Department of Defense is approximately $206,000 in Fiscal Years 2020 - 2021. This includes $122,000 in expenses and $84,000 in DoD labor.

Generated on 2021 Jan 05 RefID: 0-CFE8341

Executive Summary

As required by section 862(b) of the National Defense Authorization Act (NDAA) for the Fiscal Year (FY) 2020 (P.L. 116-92), the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)), in consultation with Under Secretary of Defense for Research and Engineering (USD(R&E)), the Under Secretary of Defense for Personnel and Readiness (USD(P&R)), and the Chief Information Officer (CIO) of the Department of Defense (DoD), herewith provides a summary of actions that have been implemented to support Software Development and Software Acquisition Training and Management Programs.

This report is a continuation of efforts initiated after the publication of the 2018 Defense Science Board (DSB) report titled "Design and Acquisition of Software for Defense Systems", the 2019 Defense Innovation Board (DIB) report titled "Software Is Never Done: Refactoring the Acquisition Code for Competitive Advantage", also known as the Software Acquisition and Practices (SWAP) report, and the August 2020 initial report submitted to congressional defense committees in response to FY20 NDAA section 862(b). This report complements other ongoing congressional efforts related to software and workforce development:

- Sec. 230. Policy on Talent Management of Digital Expertise and Software Professionals;
- Sec. 255. Department-wide Software Science and Technology Strategy;
- Sec. 256. Artificial Intelligence Education Strategy; and
- Sec. 800. Authority for Continuous Integration and Delivery of Software Applications and Upgrades to Embedded Systems.

The DoD imperative to establish and continue to cultivate a software capable workforce is critical to addressing the objectives set forth in the National Defense Strategy. Ultimately, the goal of the actions initiated by the response to FY20 NDAA section 862(b), as described in this final report, is to ensure that the defense workforce has the necessary training and tools to anticipate the demands of an ever-changing digital environment.

This report and its accompanying appendices describe the approach developed by A&S and its partners to meet the requirements established under FY20 NDAA section 862(b). This includes the identification of software training, the development of an initial software competency menu, the incorporation of software competencies in existing DoD workforce requirements, the identification of potential career paths, and the creation of a training implementation plan to validate course curriculum and delivery for software acquisition professionals.

To best address the concept that software is never done, the main report addresses overall processes and the appendices provide the details on products developed to provide the ability to change with technological advancements and best practices.

Table of Contents

Overview

In the FY20 NDAA, Congress directed the Secretary of Defense, acting through the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)) and in coordination with the Under Secretary of Defense for Research and Engineering (USD(R&E)), the Under Secretary of Defense for Personnel and Readiness (USD(P&R)), and the Chief Information Officer (CIO) for the Department of Defense (DoD), to establish software development and software acquisition training and management programs for all software acquisition professionals, software developers, and other appropriate individuals (as determined by the Secretary of Defense).[1] The complete FY20 NDAA section 862: Software Development and Software Acquisition and Training and Management Programs is included as Appendix A.

This effort is complementary to other FY20 NDAA sections that emphasize workforce development and enabling processes, including:

- Sec. 230. Policy on Talent Management of Digital Expertise and Software Professionals;
- Sec. 255. Department-wide Software Science and Technology Strategy;
- Sec. 256. Artificial Intelligence Education Strategy; and
- Sec. 800. Authority for Continuous Integration and Delivery of Software Applications and Upgrades to Embedded Systems.

Building upon the approach articulated in the Initial Report to Congress on FY20 NDAA section 862(b)(1)(a), attached as Appendix B, A&S leveraged expertise from the established DoD Software Workforce Working Group (SWWG). The SWWG, composed of acquisition and software leadership within A&S and A&S Human Capital Initiatives (HCI) and software and workforce subject matter experts from the Army, Navy, Air Force, DoD CIO, R&E, P&R, Defense Acquisition University (DAU), Air Force Institute of Technology, National Security Innovation Network, Joint Artificial Intelligence Center, and National Security Commission on Artificial Intelligence, worked collaboratively to research and provide the implementation plan. The following strategy incorporates recommendations provided in both the 2018 Defense Science Board (DSB) report titled "Design and Acquisition of Software for Defense Systems" and the 2019 Defense Innovation Board (DIB) report titled "Software Is Never Done: Refactoring the Acquisition Code for Competitive Advantage", also known as the Software Acquisition and Practices (SWAP) report.

This report provides an actionable and collaborative strategy to address software training and management, and as implemented, will enable the DoD's digital transformation.

[1] https://www.congress.gov/116/bills/s1790/BILLS-116s1790enr.pdf.

In this report we emphasize:

1. **The foundation of technological development, advancement, and incorporation in the DoD is people.** A restatement from the DIB report "software is made by people and for people, so digital talent matters."[2] To deliver modern software capability, there is a need to assess the wide variety of roles and positions that require understanding of knowledge of software in order to align digital talent to the DoD operation structure.
2. **Software is constantly changing.** To upskill the workforce and remain relevant with new technological advancement requires a more fluid and iterative approach to training content and delivery.
3. **Software workforce development is critical but other initiatives must be pursued in parallel.** The DSB and DIB reports both highlighted additional initiatives that supported modern software development. These activities include refactoring statutes, regulations and processes for software, a cross-program/cross-Service digital infrastructure, and changing the practice of how software is procured and developed. Together, working these activities will further accelerate the ability of the DoD to deliver modern software capability at the speed of relevance.

Report structure: The main report provides an overview of the current state of the DoD workforce, including the challenges it faces and the roles of the software acquisition professionals and software practitioners; the implementation status of software training and management programs, including a description of proposed software: competencies, certifications, training and potential career paths; and supporting workforce initiatives and enabling enterprise activities. The appendices provide details that are most subject to change with advancements in software.

[2] Defense Innovation Board, *Software Is Never Done: Refactoring the Acquisition Code for Competitive Advantage* (Department of Defense: Washington, DC, May 2019), https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/SOFTWAREISNEVERDONE_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE_FINAL.SWAP.REPORT.PDF, i.

Imperative: A Software Capable Workforce

Our national security is dependent on our ability to keep pace with technological developments.

"Success no longer goes to the country that develops a new technology first, but rather to the one that better integrates it and adapts its way of fighting."
2018 National Defense Strategy

"Software is made by people and for people, so digital talent matters **(especially internal talent)**."
2019 Defense Innovation Board Software Acquisition and Practices Study

Software is foundational to many modern technological advancements. For instance, fielding many of the R&E Modernization Priorities such as cyber, artificial intelligence, autonomy, quantum science, and 5G would not be possible without software. Not only is software critical to technology today but it is foundational to our ability to continually evolve, adapt, and respond. This cannot be achieved without a skilled workforce that is proficient in using modern software development methodologies and the latest commercial tools to rapidly and continuously deploy critical software capabilities.

Figure 1 shows the current DoD workforce in its entirety (left) and the DoD acquisition workforce (right):

Figure 1. DoD and DoD Acquisition Workforce

The current talent within the DoD workforce is a significant advantage. We have the opportunity to meet the demand of a software capable workforce by converting groups within the current DoD workforce to software experts. Combining the continual improvement of the recruitment of talent while enabling the current workforce through training opportunities increases our

readiness and is the key to success. The approach for recruitment will be addressed through the complementary effort under FY20 NDAA Sec. 230 Policy on Talent Management of Digital Expertise and Software Professionals.

Problem: A Software Capable Workforce within the DoD

In the Initial Report we stated that the problem is:

> In current defense acquisition training and management programs, knowledge of and experience in the fundamentals of modern approaches are in short supply, and acquisition professionals, such as program managers and contracting officers, often have limited familiarity with software and Agile development practices. Existing civilian and military software expertise is scattered throughout the workforce and not systematically identified, tracked, and developed. There are also few career paths available to software acquisition professionals and software developers within the DoD and the Service; therefore, there is minimal room for job growth and little incentive for talented software developers, software engineers, product managers, user experience/user interface (UX/UI) designers, data engineers, etc., to join DoD. As a result, the DoD struggles to attract new talent or take advantage of existing talent, which in turn makes it difficult to identify skill gaps in certain areas and build the new capabilities needed to fill those gaps. These shortfalls add risk to DoD's efforts to deliver quality software capability in a timely manner.

Section 862 reinforces the need for a strategy and implementation plan to address the problems stated above and also identified in the DSB and DIB reports. The following DSB and DIB report excerpts further articulate the current state of a software capable workforce within the DoD:

"The U.S. Government **does not have modern software development expertise** in its program offices or the broader functional acquisition workforce. This requires congressional engagement and **significant investment immediately**."[3] (emphasis added)

"The DoD **cannot compete and dominate** in defense software without a technical and design workforce within the Department that **can build software natively and effectively manage vendors** to do the same."[4] (emphasis added)

[3] Defense Science Board, *Design and Acquisition of Software for Defense Systems* (Department of Defense: Washington, DC, February 2018), https://dsb.cto.mil/reports/2010s/DSB_SWA_Report_FINALdelivered2-21-2018.pdf, 26.

[4] Defense Innovation Board, *Software Is Never Done: Refactoring the Acquisition Code for Competitive Advantage* (Department of Defense: Washington, DC, May 2019), https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/SOFTWAREISNEVERDONE_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE_FINAL.SWAP.REPORT.PDF, S36

To address this, the DIB SWAP report articulated:

> The *desired state* is that senior leaders, middle management, organic and contractor-based software developers are aligned in their view of how modern software is procured and developed. Acquisition professionals are aware of all of the authorities available for software programs and use them to provide flexibility and rapid delivery of capability to the field. Program leaders are able to assess the status of software (and software-intensive) programs and spot problems early in the development process, as well as provide continuous insight to senior leadership and Congress.[5]

The following section describes our overall approach and proposed implementation plan to meet the requirements under section 862 by evaluating the current DoD workforce and proposing opportunities to incorporate software training and education throughout. The appendices provide details on current status and the implementation plan.

FY20 NDAA Sec. 862 Roles and the DoD Workforce

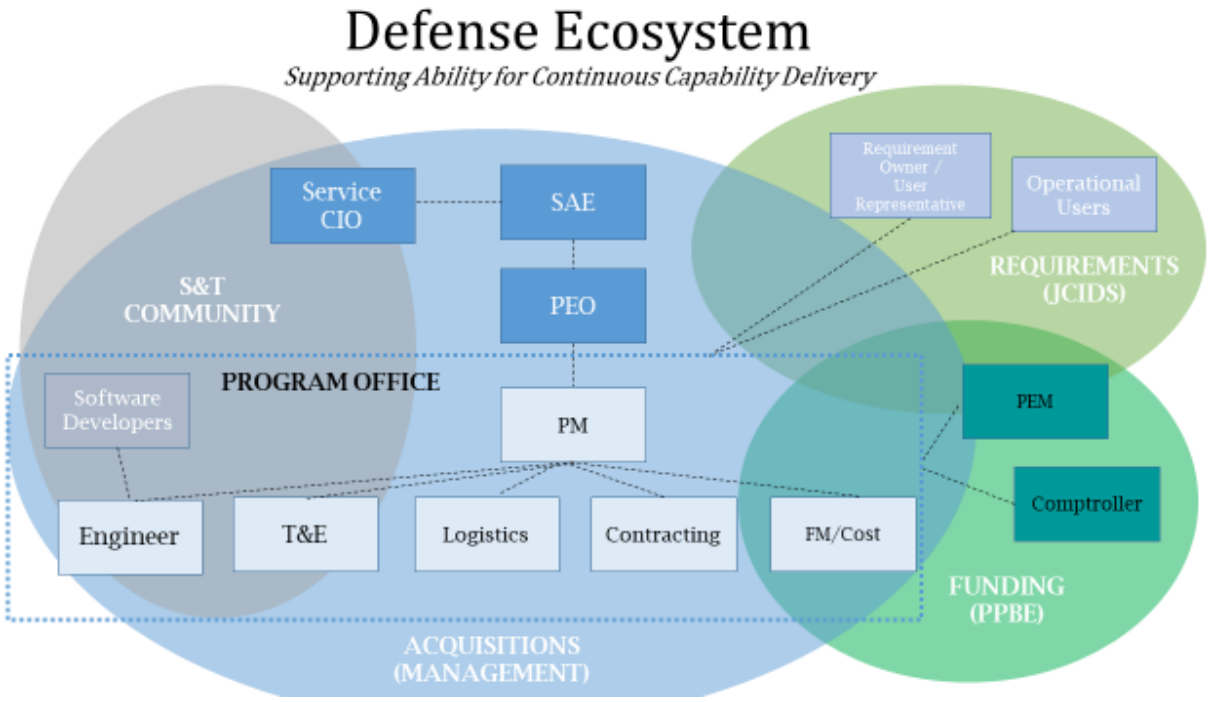
Section 862(a)(1) of the FY20 NDAA requires the establishment of "software development and software acquisition training and management programs for all software acquisition professionals, software developers, and other appropriate individuals." Section (2)(a), states "to develop and expand use of specialized training programs for the:

- Chief Information Officers (CIOs) of the military departments and the Defense Agencies,
- Service Acquisition Executives (SAEs),
- Program Executive Officers (PEOs), and
- Program Managers (PMs)."

This section aligns the roles referenced above with the current workforce within the DoD that supports capability delivery. As Figure 2 demonstrates, the current acquisition workforce is composed of multiple communities and roles**.** This snapshot includes the Science and Technology (S&T) community, or the R&E community, as well as the processes within the Defense Acquisition System (DAS). The roles listed are based on current roles, with the exception of Software Developer which was specifically referenced in FY20 NDAA Sec 862(a)(1). The figure is **not** a comprehensive list of roles and/or positions and is **not** to scale—the focus on Acquisition Professionals (Management) aligns to the responsibility of A&S with respect to the workforce in combination with the roles highlighted in section 862.

[5] Ibid., 41.

Figure 2. Defense Ecosystem



Note:

- The Defense Acquisition System is made up of three processes: Acquisition Process "Management", Joint Capabilities Integration and Development System (JCIDS) Process "Requirements", and Planning, Programming, Budget and Execution (PPBE) Process.
- The Acquisition Workforce represented includes:
    - Leadership positions referenced in FY20 NDAA Sec. 862: SAEs, PEOs, and military department chief information officers
    - Acquisition functional areas represented as aligned to "Back-to-Basics" (BtB) for Defense Acquisition Workforce, dated September 2, 2020, included in Appendix C. The BtB acquisition functional areas are:
        - Program Management (PM),
        - Engineering (EN),
        - Test and Evaluation (T&E),
        - Contracting,
        - Life Cycle Logistics, and
        - Business Financial Management (FM)/Cost Estimating.

- The Acquisition Workforce is 91 percent civilian and nine percent military as noted by the OUSD(A&S) office of Human Capital Initiative (HCI).[6]

The depiction of software developers in Figure 2 is one example of how they support capability development. Software developers can support program offices, logistics centers, and labs, and may be outside the acquisition system entirely, i.e., operators. The BtB memo, Appendix C, is only applicable to the Acquisition Workforce. The cyber workforce, as addressed by the DoD Cyber Workforce Framework (DCWF), also includes software developers and additional roles that support valuable capability delivery further defined in DoD Directive 8140.01 Cyber Workforce Management.[7]

To be able to navigate the wide variety of roles that are highlighted and provide a tailoring of training for the individual and role, we propose the following:

Defining the DoD Software Workforce

The following two proposed categories encompass multiple roles. Industry best practices within organizations that adopt modern software practices (i.e., Agile, DevSecOps) emphasize that an individual may fulfill multiple roles, and are usually not confined to one role—this concept will be expanded upon in potential software career paths.[8] To meet the imperative of a software capable workforce, the DoD needs both categories and the roles that align within each.

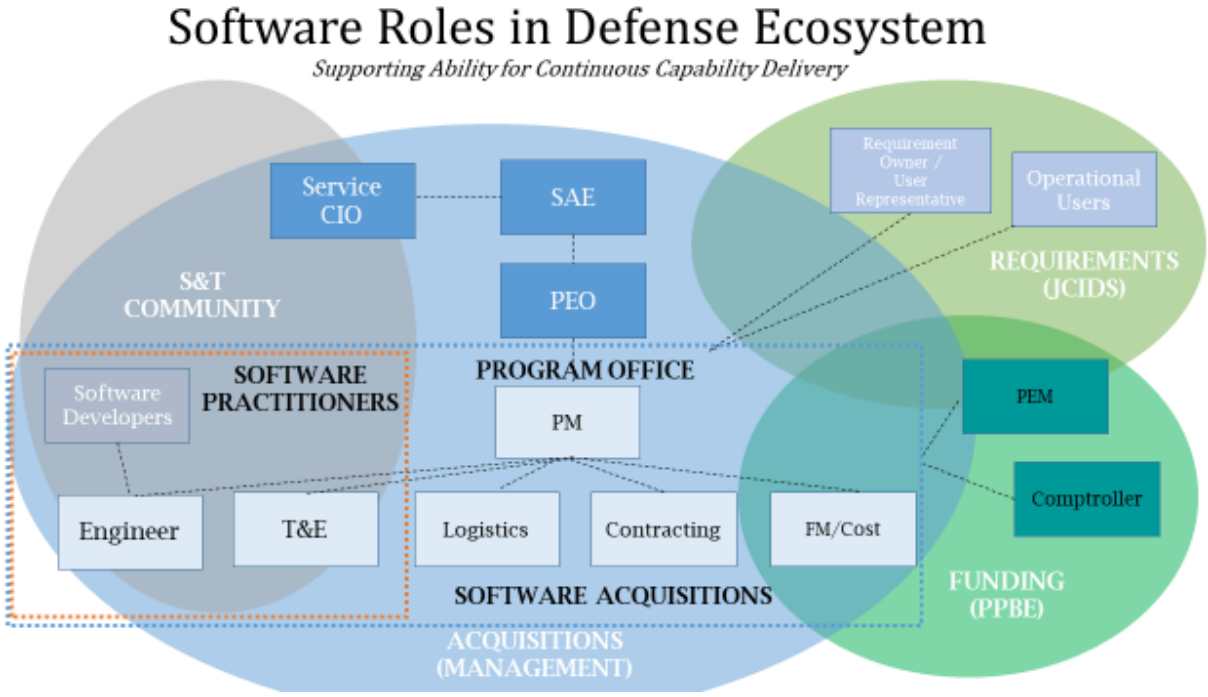
- **Software Acquisition Professionals**: A member of the DoD acquisition workforce who provides expertise in the procurement, management, and/or development of software intensive processes and systems such as business systems, weapons systems, supplies, or services to satisfy DoD needs and support military operations. As stated by the DIB, these professionals support the effective management of vendors.
    - Example software acquisition roles are: program managers, financial managers, contracting officers, and logisticians.
    - As defined above, these roles above are representative of members who are **not** directly supporting product delivery but rather support the ability of valuable capability delivery through navigation and leveraging of the DoD 5000.02 Adaptive Acquisition Framework (AAF), Federal Acquisition Regulation (FAR), DoD 5000.74 Financial Management Regulation (FMR) and other policies and regulations DoD and service-specific that guide the acquisition workforce.
    - Leadership that supports software acquisition professionals include Program Executive Officers (PEOs), Service Acquisition Executives (SAEs), and the military department CIOs providing technical leadership.

[6] https://www.hci.mil/docs/Workforce_Metrics/FY20Q2/FY20(Q2)OVERALLDefenseAcquisitionWorkforce (DAW) InformationSummary.pdf.
[7] https://public.cyber.mil/cw/dcwf/.
[8] Niels Pflaeging, *Organize for Complexity How to Get Life Back into Work to Build the High-Performance Organization* (Betacodex Publishing, 2014).

- **Software Practitioners:** Software practitioners are defined as those actually implementing software and delivering capability to the users and can be fulfilled organically (military and civilian) or contracted for with the industrial base. As stated by the DIB, these professionals can build software natively.
    - Example software practitioner roles are: software developers, software engineers, product managers, cloud architects, user experience specialists, etc.
    - Software practitioners can also be software acquisition professionals (see Figure 3). The explicit distinction emphasizes the recommendation that technical advisors for software acquisition should be current software practitioners, mandated by the speed of technology.
    - Software practitioners can exist outside of the acquisition workforce and are included in the cyber workforce under DCWF and DoD Directive 8140.01.
    - Leadership that supports software practitioners include the military department chief information officers, their cyber security accreditation authority, policy staffs, etc.

Figure 3 is the current recommendation of how to align Software Acquisition Professionals and Software Practitioners (both within Acquisition and non-Acquisition workforce) within the Defense Ecosystem. The recommendation is based on the cross-community participation within the SWWG.

Figure 3. Software Practitioners and Software Acquisition Professionals in Defense Ecosystem



Software practitioners and software acquisition professionals work together to deliver valuable capability throughout the DoD, from business systems to warfighter capability, at the speed of relevance. Interaction occurs constantly due to the speed of software development and deployment. Examples of collaboration include supporting new requirement development and contracting processes as required, providing feedback on existing contracts (services and products), aligning technical and acquisition strategies, and supporting the funding and obligation actions and strategies.

Software Training and Management Programs

OUSD(A&S) designated the SWWG as the responsible group to create software competencies, software certifications, software training and management programs, and potential software career paths. Together these activities will support the development of a software capable workforce leveraging our current workforce and create the structure and opportunity for new talent that joins the defense workforce. The SWWG will lead the initial development and set up feedback loops that ensure that the build-measure-learn loop is informed both by the software workforce and technological change and advancements. The SWWG as described is a combination of expertise across the DoD, led by acquisition and software experts within A&S. Its membership includes: A&S HCI and software and workforce subject matter experts from the Army, Navy, Air Force, DoD CIO, R&E, P&R, DAU, Air Force Institute of Technology, National Security Innovation Network, Joint Artificial Intelligence Center, and National Security Commission on Artificial Intelligence. Established in May 2019 following the release of the DIB report, the group is cultivating and maintaining relationships across the community to establish feedback loops; constantly soliciting and incorporating input from across the Department and the Services, other federal agencies, and industry; and using agile learning design as a foundational principle, as shown in the implementation status. The SWWG collected best practices based on numerous engagements, which are provided in Appendix D.

As required in section 862, the following subsections will explain the software competencies, software training, software certifications, and potential software career paths and reference the supporting appendices.

Software Competencies.

Software competencies are defined as the observable, measurable pattern of knowledge, skills, abilities, behaviors, and other characteristics needed to perform software work roles or software occupational functions successfully. Competency requirements vary by role; for example, software practitioners and software acquisition professionals would differ in depth within competencies. Competencies also establish the foundation for course curriculum requirements. The Software Competency Topics are a defined set of specific patterns of knowledge and represent the software foundation required for all the roles, including leadership, identified in the software workforce.

Table 1. Software Competency Topics

Competency Topics		Competency Descriptions
1	Software Foundational Concepts & the DoD	Describe digital services in the 21st century, including what they are, who provides them, how they are delivered, and why they are important--fundamentals of agile and DevSecOps.
2	Capabilities Needs Development/Evolution & User Engagement/Design	The ability to identify stakeholders and translate requirements and establishment of user engagement throughout the entirety of capability development and delivery. User-centric design: Integrating design-thinking, human-centered design, UX/HCI into system development & deployment
3	Software Architecture and Data Management	The ability to plan for long-term maintainability using architectural structures, viewpoints, styles, design decisions and frameworks, and the underlying data structures. Understanding various cloud services, cloud native architecture as well as edge sensing and computing enablers for capability delivery
4	Software Development and Delivery	**Development**: The ability to implement software that minimizes complexity, anticipate change, plan for verification, reuse software, use coding standards and estimate effort. Understanding the continual incorporation of security and test as a building block for delivery
		Delivery: Continuous Integration and Continuous Delivery (CI/CD) using modern software practices
5	Acquisition Technical Expertise and Change	Effectively use techniques for acquiring digital service solutions in your solicitation or acquisition strategy and administering and managing digital service contracts

The current detailed software competencies were developed by reviewing multiple industry models and academic research and align with current DoD efforts. The current detailed software competencies are included in Appendix E.

The proposed competencies, certifications, and career paths are intended to be a baseline that can be adjusted and modified as required by the Services and Components based upon program and mission needs. Appendix F demonstrates how software competencies are being proposed for incorporation into the Engineering and Technical Management (ETM) functional area.

Software Training.

The SWWG cultivated a list of software education and training opportunities currently available to the defense workforce to begin to identify gaps in training and to serve as a resource. This list is not exhaustive, but does include a multitude of online, in-person, and blended learning opportunities and other training resources provided by the federal government, the Services, academia, and industry that can be leveraged by individuals today.

The current software training list, attached as Appendix G, aligns to the DIB SWAP report statement: "software skills can be acquired through self-directed and even informal training resources such as on-demand, online webinars, and coding boot camps, etc."[9] The current list articulates various training methods and sources: open-source, commercial, government-industry exchange programs, and DoD-specifically developed (both in-person and virtual classroom offerings). DoD-specific training can, and whenever possible should, be additive to open-source and commercially available training.

Appendix G does not reflect a training curriculum or recommended courses, nor does it replace any existing training curriculum leveraged by the DoD today. Rather, it is meant to be a resource of available software training from multiple sources that will be updated by the SWWG.

Software Certifications.

Leveraging the software competencies and available commercial software training identified, the SWWG recommends to align with industry best practices such as "digital badging", defined as a validated indicator of an accomplishment or skill that can be displayed, accessed, and verified online. Utilizing digital badging allows for maximum customization at individual and role level both for individual courses and the full curriculum. For example, "IBM's human resources department found a correlation between badges and engagement…. Student enrollments increased by 129 percent and the percentage of enrollees who actually completed courses increased by 226 percent. The number of students passing the end of course exam increased by 694 percent compared to the six-week period leading up to the introduction of digital badges. It's

[9] https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/SOFTWAREISNEVERDONE_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE_FINAL.SWAP.REPORT.PDF.

important to note there were no other contributing factors to this success, like promotions or announcements from IBM executives."[10]

This strategy provides for the opportunity to start small, learn, and iterate. Furthermore, this approach is also consistent with and provides a basis to build upon to meet the direction in section 862 of the FY20 NDAA, which directed the Secretary of Defense to implement a certification program for the acquisition workforce based on nationally or internationally recognized standards.

DAU is implementing the practice through credentials providing responsive and timely learning experiences where students can self-select training, to grow and deepen their skills. By offering learning in smaller, more job-specific credentials, DAU aims to help DoD evolve beyond today's three-level certification framework and more effectively meet the intent of the Defense Acquisition Workforce Improvement Act (DAWIA). More information is available at: https://www.dau.edu/training/pages/credentials.aspx.

Digital badging (credentialing) provides a foundation for training and a method to identify and track expertise. "Because digital badges are embedded with specific information about an achievement, IBM's systems can quickly identify expertise at the granular level, including specific skills, relevance and date of achievement. That information allows IBM to match and deploy the right people to solve business problems."[11] Combining existing DAWIA certifications with DAU credentials can offer a similar opportunity for insight and improved talent management.

Appendices F and H provide examples for software practitioners and software acquisition professionals.

Potential Software Career Paths.

To address potential software career paths and understand how to best to incorporate these paths within the DoD ecosystem, the SWWG plans to utilize the DoD acquisition workforce as an initial test cohort. The SWWG supports two efforts:

- Partnership and participation with OUSD(P&R) DoD Digital Workforce Group: DoD-wide, led by the Deputy Assistant Secretary of Defense, Civilian Personnel Policy, P&R Cyber/IT Executive Lead, is working to support the variety of digital workforce career paths that are emerging in software, digital engineering, data science, artificial intelligence, etc., to collaborate and improve efficiency in managing the DoD digital workforce.

[10] David Leaser, "Do Digital Badges Really Provide Value to Businesses?" IBM Training and Skills Blog, 2 Aug. 2019, www.ibm.com/blogs/ibm-training/do-digital-badges-really-provide-value-to-businesses/.
[11] David Leaser, "Do Digital Badges Really Provide Value to Businesses?" IBM Training and Skills Blog, 2 Aug. 2019, www.ibm.com/blogs/ibm-training/do-digital-badges-really-provide-value-to-businesses/.

- Leveraging software certifications and digital badging as a way to identify those qualified to fill roles, allowing for the Government to more seamlessly support various roles within a software organization.
    - Software Practitioner Example: A software developer can serve the role of a cyber-security engineer if qualified for both positions via certifications and digital badging.
    - Software Acquisition Professional Example: A program manager can fulfill the role of a product owner or a product manager if qualified for both positions via certifications and digital badging.
        - NOTE: The one exception for software acquisition professionals is contracting. Contracting officer positions must be filled by an individual that not only has been certified via training but also, as defined by statute, has a warrant to support the award of contracts.

Current Implementation Status: Software Development and Software Acquisition Training and Management Programs

The SWWG has created an initial set of software competencies which informed the proposed training content and will support certification recommendations. The SWWG plans to incorporate these resources into currently available training platforms, such as the Defense Acquisition University Learning Management System.

Software Practitioners. An example of the collaboration, partnership, and augmentation of current processes is the ETM career fields update led by R&E with active support from A&S/SWWG. ETM has incorporated relevant software competencies (proposed by the SWWG) into their already established career field competency model as highlighted in Appendix F. Additionally, across the services to populate software factories with organic developers, the services are implementing tailored commercial training that supports their mission requirements.

Software Acquisition Professionals. The above ETM example is a model that could be extended to other acquisition functional areas. The SWWG intends to leverage the opportunity provided with the current curriculum updates required by the September 2, 2002, memorandum BtB for the Defense Acquisition Workforce (Appendix C). BtB aims to streamline the acquisition functional area framework while prioritizing limited training resources for the Defense Acquisition Workforce (AWF) who develop, acquire, and sustain operational capability. The implementation began October 1, 2020, with deployment planned for October 1, 2021. Additionally, Appendix H provides a roadmap for software acquisition training content and delivery.

With the support of DAU, the software training content and software certifications will be widely accessible and easy to navigate.

Highlights: Supplementing Current Workforce Initiatives

The work being done by the SWWG to meet the requirements established under section 862 is just one example of efforts currently underway across the DoD and the Services to improve modern software development. There has also been significant momentum across the Department and the Services over the past year to align digital efforts (e.g., artificial intelligence, cyber, software, etc.). The existing workforce examples provided below are not all encompassing and are only a sample of the incredible on-going work and collaboration.

Given that section 862 focuses on training, the SWWG has identified and hopes to collaborate with a number of existing and new training programs. For example, DAU has revised its software acquisition management curriculum to keep pace with emerging technologies, commercial practices, and DoD lessons learned. The curriculum consists of three components: commercial online technical training provided through a partnership with Coursera; DAU authored online courses revised to include more curriculum on artificial intelligence, Agile software development, DoD cloud computing, etc., and immersive classroom experiences such as a two-day DevSecOps workshop. DAU has also signed a Memorandum of Agreement with George Mason University to establish a framework for exchanging visiting faculty. A sampling of topics that will be taught include data analytics, digital engineering, cybersecurity, and artificial intelligence. Furthermore, DAU also supports DoD Information Technology (IT) leaders and the acquisition workforce needs with significant software acquisition management training.

The Services are also expanding their curriculum to better train Service Members in modern software development. In addition to its current academic offerings, the Air Force Institute of Technology is creating a set of curriculum that speaks to "Agile/DevSecOps" for targeted functional areas. The first functional specialties to be targeted will be program managers, contracting, and finance. The intent is to provide instruction on the skills, tools, and techniques that are particular to managing, contracting, and budgeting/costing for agile/DevSecOps programs that are not currently taught in current fundamental acquisition courses. Through one of its software factories (BESPIN) and commercial vendor partners such as Udacity, Udemy, and Pluralsight, the Air Force also launched Digital University to "upskill" Airmen in artificial intelligence/machine learning, cybersecurity, and software development. Platform One, another Air Force software factory, also recently announced the launch of the "DoD Dojo". Dojos, an immersive learning experience where the entire team supporting software capability development and deployment actively leverages new technology and new ways of working together by completing work in a six-week period, have been successful at large-scale commercial companies such as Target and Walmart. The first iterations will be focused on DevSecOps principles.

The Army recently announced the establishment of its first Soldier-led modern software factory. The program, led by Army Futures Command in Austin, Texas, will complement other new Army initiatives such as the Army Artificial Intelligence Task Force and Artificial Intelligence Work Force Development programs. In September 2020, the Army partnered with Austin Community College to provide training to Soldiers and students in software development, leadership, and problem solving. The Software Factory is looking to be fully operational in June 2021. The Software Factory is focused on upskilling cohorts of Soldiers through a year of coding bootcamps, hands-on pairing, and immersive internships with the Austin tech community. At the end of the training, Soldiers will spend up to three years in the factory developing modern software capabilities that enable Soldiers around the globe.

The U.S. Naval Community College, part of the Navy's Education for Seapower, is currently developing partnerships with academic institutions across the United States to eventually offer accredited associate's degrees for enlisted personnel in academic fields that directly impact the National Defense Strategy, particularly in science, technology, engineering and mathematics. The goal is to be operational by 2021.

Experiential training, such as exchange programs and fellowships, is also a valuable learning tool. Over the past few years, existing Service exchange programs have expanded to include more technical opportunities. Two newer exchange programs are the DoD Public Private Talent Exchange (PPTE) program and the AFVentures Fellowship. Exchange programs for the second cohort of the PPTE program recently concluded. During the second cohort, a human capital expert from Deloitte detailed to HCI and provided invaluable information about Deloitte's workforce efforts, including certification, training, and career paths in software-related fields that the SWWG reviewed as a model. The Air Force, in partnership with AFWERX, initiated the AFVentures Fellowship. The program is a six-to-eight week immersion for Airmen to participate in Silicon Valley companies. Cohorts are expected to run every three months through 2024. Through Platform One and the DevSecOps Initiative, the Air Force also offers a six-month residency, which is available to military and civilians (federal) in subject matter areas such as software development.

Communities across the Department and the Services have taken the initiative to stand up communities of practices and, most importantly, share lessons learned. As shown in Appendix D, the development of communities of practice is a practice commonly used throughout industry. The DoD Enterprise DevSecOps Community of Practice, co-led by CIO and OUSD(A&S), is an extremely active group supported by leadership that hosts monthly "Ask Me Anything" events and shares multiple resources. NavalX, the Navy's "super-connector," provides resources such as playbooks (e.g., implementing agile scrum) and training to the Naval workforce. In addition, through NavalX, the Centers for Adaptive Warfighting provides warfighter-ready courses in industry best practices (e.g., military scrum). Resources are also available to civilians and other Services on their website. Airmen and Marines have also built their own communities of coders

to support their fellow warfighters. The websites for Airmen, Marine, and Supra Coders (specific to U.S. Space Force coders) provide information on their projects and training resources, including a three-month software development immersive with its second and third cohorts in October and November 2020. These coders are also sharing best practices with each other.

There are also numerous digital efforts already underway across the Department and the Services. Though challenging, members from each community are working together to align workforce efforts. As previously mentioned, OUSD(P&R) recently established a DoD Digital Workforce Group in an effort to understand existing digital workforce efforts. Members of the SWWG are participating in the working group. The Department is also currently working to implement section 230 of the FY20 NDAA, which mandates new policy to promote and maintain digital expertise and software development as core competencies of civilian and military workforces. Members of the SWWG are supporting this effort. Another congressional effort that SWWG members participate in is the work being led by the Joint Artificial Intelligence Center (JAIC) to implement FY20 NDAA section 256. This section mandates the Secretary of Defense develop a strategy for educating Service Members in relevant occupational fields on matters relating to artificial intelligence.

Two other digital efforts that are entwined with software are being led by the DoD CIO and the Air Force Digital Talent Management Task Force. The DoD CIO is leading the development of the DoD 8140 policy series for comprehensive cyber workforce management. The Directive, reissued on October 5, 2020, defines and unifies the cyber workforce to include Information Technology, Cybersecurity, Intel (Cyber), Cyber Effects, and Enabling workforce elements. It also established the DoD Cyber Workforce Framework (DCWF) as the authoritative reference for cyber work. When fully implemented, the DoD 8140 policy series will leverage the DCWF to identify, track, and report cyber positions; directly supporting requirements of the Federal Cybersecurity Assessment Act (FCWAA) of 2015. It will also establish a role-based approach to cyber workforce qualification and career progression.

It will be essential for the SWWG to work alongside all of these efforts (and others not mentioned) to align software-related competencies, training, and career paths.

Highlights: Enabling Enterprise Activities

As highlighted in his book, *Ahead in the Cloud: Best Practices for Navigating the Future of Enterprise IT*, Stephen Orban, a computer scientist and the Head of Strategy at Amazon Web Services, argues that there are three P's needed to support change: People, Processes, and Platform (Technology). These examples are a sampling of associated efforts that are complementary to the above and are included to highlight the imperative of supporting enabling activities to provide a foundation for our workforce.

People (Community)

DoD Software Workforce Working Group

The working group was established by OUSD(A&S) in May 2019 to support implementation of the DIB 2019 report. The mission of the working group is to guide and support the civilian and military workforce in the rapid development of modern software to the field using DevSecOps practices by working with relevant stakeholders to develop training for acquisition professionals and career paths to better recruit, hire, and retain software talent.

DoD Enterprise DevSecOps Community of Practice

Established in 2018 and co-led by DoD CIO and OUSD(A&S). Since its founding, the community has grown to include hundreds of members from all Services, DoD support Agencies, and commercial industry.

DoD Acquisition INNOVATORS Community of Practice

Established in 2020 and co-led by OUSD(A&S) and Defense Digital Services (DDS), this community of practice aims to connect the DoD acquisition workforce, openly share information, improve skills, and enhance the DoD acquisition community.

Processes

Adaptive Acquisition Framework (AAF) – Namely the Software Acquisition Pathway

The AAF is intended to allow Program Managers and Program Management Offices the opportunity to choose the right pathway(s) for the capability they are developing, procuring and or fielding as quickly as possible, The Software Acquisition Pathway "objective is to facilitate rapid and iterative delivery of software capability to the user. This pathway integrates modern software development practice such as Agile Software Development, DevSecOps, and Lean Practices.[12]

Single Appropriation for Software and Digital Technology Pilot (i.e., Budget Activity (BA) "BA-08" Pilot)

Based on recommendations from the Agile Software pilot programs as directed in sections 873 and 874 of the FY18 NDAA and the DSB and DIB reports, OUSD(A&S) and OSD Comptroller proposed a pilot to congress that realigns funding from various appropriations for selected Software Pilot Programs into a new single appropriation under Research, Development, Test & Evaluation (RDT&E). Pending approval, this pilot effort will evaluate the efficacy of a single funding category for software and digital technology.

[12] https://aaf.dau.edu/aaf/software/.

Technology

DoD DevSecOps Reference Design
Published in August 2019, the document was endorsed jointly by the DOD CIO and OUSD(A&S) in the memorandum attached as Appendix I. It can be found here: https://dodcio.defense.gov/Portals/0/Documents/DoD%20Enterprise%20DevSecOps%20Reference%20Design%20v1.0_Public%20Release.pdf?ver=2019-09-26-115824-583>

Joint Enterprise Defense Infrastructure (JEDI) Contract
JEDI Cloud is the initiative that will deploy foundational cloud technology, while leveraging commercial parity, to the entire Department, with a focus where our military operates—from the home front to the tactical edge. More information is available here: https://cloud.mil/JEDI-Cloud/

Establishment of Enterprise Services, i.e., Air Force (AF) Platform One
The pathfinder for this effort is the Air Force's office of the Chief Software Officer (CSO). More information is available here: https://software.af.mil and https://software.af.mil/dsop/. The DoD CIO and the Defense Information Security Agency are working closely with the DoD Enterprise DevSecOps community of practice and Senior Steering Group to move Air Force solutions to enterprise scale offerings leveraging both the Air Force efforts with Cloud One and Platform to bring the same capabilities to the DoD's JEDI effort when possible.

Next Steps: Software Development and Software Acquisition Training and Management Programs

The vision is to embody the concept that software is never done in the DoD's Software Development and Software Acquisition Training and Management Programs. To keep pace with known and unpredictable changes in software technologies, methods and policy, software competencies and corresponding software training, certifications, and career paths will need to be continually evaluated and updated. To be best positioned to adapt and incorporate, the vision is the stand-up of integrated learning platform(s). Implementing Total Learning Architecture (TLA) as defined by the Advanced Distributed Learning (ADL) Initiative which provides data standards, interoperability specifications, IT architectural schemes and policies to enable federal digital learning ecosystems allows for a learning platform that incorporates DoD-Specific Training, DoD-Procured Training, free training and alternate learning avenues and service-specific training opportunities.[13] The learning platform can provide the ability to identify expertise within the DoD at a granular level similar to IBM's implementation of digital badging. One example is leveraging DAU's current learning platform modernization efforts. To best adapt and adopt technology we need a workforce that can quickly access information, collaborate, and be identified. The cross-cutting community created through the SWWG can support the DoD by continually evaluating and updating baseline software: competencies,

[13] https://adlnet.gov/news/2020/07/30/Building-the-Infrastructure-for-DoD-Digital-Learning-Modernization/.

training, certifications and career paths that can support the Services and Components ability to apply to deliver capability at the speed of relevance.

Additional Recommendations: Statutory and Legislative

The Department greatly appreciates Congress's continued and broad support to improve the many facets of DoD digital-related capabilities, including software workforce capabilities. DoD notes the inclusion of additional supportive requirements in the House and Senate FY 2021 National Defense Authorization Act bills. For convenience, the following table lists the various examples of congressional support in recent NDAAs.

Table 2: Examples of Congressional Support

FY18 NDAA	**Comments**
Section 872, Defense Innovation Board Analysis of Software Acquisition Regulations	The DIB submitted final report, which provided draft legislative language on "special pathways for rapid acquisition of software applications and upgrades," to Congress in May 2019. Much of this language was included in FY20 NDAA section 800, "Authority for Continuous Integration and Delivery of Software Applications and Upgrades to Embedded Systems"
FY19 NDAA	**Comments**
Section 868, Implementation of Recommendations of the Final Report of the Defense Science Board Task Force on the Design and Acquisition of Software for Defense Systems	OUSD(A&S) submitted final report to Congress in August 2020 on the DoD's progress on implementing DSB recommendations
FY20 NDAA	**Comments**
Section 230, Policy on the Talent Management of Digital Expertise and Software Professionals	Designation of Chief Digital Engineering Recruitment and Management Officer is underway; feedback received from the coordination process for the Implementation Plan is being adjudicated
Section 255, Department-Wide Software Science and Technology Strategy	OUSD(R&E) writing draft report in collaboration with OUSD(A&S), OUSD(CIO), DOT&E, and Service stakeholders. Report currently due June 20, 2021.
Section 256, Artificial Intelligence Education Strategy	DoD CIO, Joint Artificial Intelligence Center submitted implementation plan, with input from members of the SWWG, in September 2020; JAIC is currently working on a pilot program
Section 800, Authority for Continuous Integration and Delivery of Software Applications and Upgrades to Embedded Systems	On October 2, 2020, OUSD(A&S) issued DoD Instruction 5000.87, "Operation of the Software Acquisition Pathway"

Section 862, Software Development and Software Acquisition Training and Management Programs	Related to the workforce recommendations (line of effort "C"), particularly C2 (acquisition workforce training), made by the DIB in their 2019 SWAP report. Initial report submitted to Congress in August 2020; this report is the final report
FY21 H.R. 6396	**Comments**
Section 242, Training for Human Resources Personnel in AI & Related Topics	Recommends the development and implementation of training for human resources personnel in the fields of software development, data science, and artificial intelligence (related to sec 862)
Section 245, Self-Directed Training in Artificial Intelligence	Requests that a list of approved online courses relating to artificial intelligence that may be taken by civilian employees of the Department of Defense and members of the Armed Forces (related to section 862 because (1) AI and software development are intertwined, and (2) the SWWG already developed a similar list of available programs (commercial and government) in software development and software-related fields, including AI
FY21 S. 4049	**Comments**
Section 881, Inclusion of Software in Government Performance of Acquisition Function	Related to a recommendation made by the SWWG, HCI submitted an FY21 legislative proposal in fall 2019

While DoD has no recommendations to change existing laws to implement section 862, DoD notes that there may be opportunity to unify and synchronize digital-related statutory requirements across separate areas of the digital domain which commonly include reference to software capability. DoD will continue to synchronize its software workforce initiatives with other DoD digital initiatives and is committed to providing periodic update briefings to professional staffers.

Summary

> New commercial technology will change society and, ultimately the character of war. The fact that many technology developments will come from the commercial sector means that state competitors and non-state actors will have access to them, a fact that risks eroding the conventional overmatch to which our Nation has grown accustomed.
> *-2018 National Defense Strategy Summary*

The ability to adapt and respond to rapid change is more critical now than it has been in the past. The need for a software capable workforce is fundamental for national security and it is needed **now**. The SWWG is working across the DoD to ensure that software training and software careers are embedded throughout the DoD. As stated, the current talent already extant in the DoD workforce is our significant advantage.

The SWWG will continue to provide visibility on current training accessibility opportunities available to the Department. We need to ensure the opportunity to learn is provided, the stakes are too high otherwise:

> The problem with being too busy to read [learn] is that you learn by experience (or by your men's experience), **i.e. the hard way.** By reading, you learn through other's experiences, generally a better way of doing business, especially in our line of work where the consequences of incompetence are so final for young men [and women]."
> *-Gen. James Mattis*

Independent Assessment: Defense Innovation Board

Section 862 of the FY20 NDAA requires an independent assessment of this report by the DIB. Per the NDAA requirement, the DIB—a federal advisory committee that provides advice to the Secretary of Defense governed by the Federal Advisory Committee Act – conducted the assessment at Attachment 1.

Included Appendices

Appendix A. FY20 NDAA Sec. 862 Software Development and Software Acquisition Training and Management Programs

Appendix B. Initial Report to Congress on FY20 NDAA Section 862(b)(1)(a) Software Development and Software Acquisition Training and Management Programs

Appendix C. USD(A&S) Back-To-Basics memo (2 Sep 2020)

Appendix D. Summary of Best Practices Learned to Date

Appendix E. Draft Software Competency Menu

Appendix F. Incorporation of Software Competencies into the Engineering and Technical Management (ETM) Career Field

Appendix G. Draft Current Software Training Inventory

Appendix H. Training Implementation Plan for Software Acquisition Professionals

Appendix I. Endorsement memo of DoD Enterprise DevSecOps Reference Design

Attachment 1

Fiscal Year 2020 National Defense Authorization Act §862(b)(2)(D) Defense Innovation Board Assessment: Department of Defense Implementation of Software Development and Software Acquisition Training and Management Programs

The Defense Innovation Board (DIB), a federal advisory committee that provides advice to the Secretary of Defense, was directed in FY20 NDAA §862 to conduct an independent assessment of Department of Defense (DoD) efforts to establish software development and acquisition training and management programs as part of the Department's reporting requirement to Congress. The DIB Science and Technology (S&T) sub-committee reviewed the final report summarizing the actions that have been implemented to support Software Development and Software Acquisition Training and Management Programs. The report represents that work of the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)), in consultation with Under Secretary of Defense for Research and Engineering (USD(R&E)), the Under Secretary of Defense for Personnel and Readiness (USD(P&R)), and the Chief Information Officer (CIO) of the Department of Defense (DoD).

The report leverages the expertise of the DoD Software Workforce Working Group (SWWG), which serves as the coordinating body within the Office of the Secretary of Defense (OSD) to create software competencies, certifications, training and management programs, and career paths. The S&T sub-committee strongly endorses the work of SWWG as a means of implementing the types of changes that are required within DoD's software workforce.

The actions described in the report are well-aligned with one of the three primary themes in the DIB's report on Software Acquisition and Practices (SWAP):

> *Software is made by people and for people, so digital talent matters.* DoD's current personnel processes and culture will not allow its military and civilian software capabilities to grow nearly fast or deep enough to meet its mission needs. New mechanisms are needed for attracting, educating, retaining, and promoting digital talent and for supporting the workforce to follow modern practices, including developing software hand in hand with users.

In particular, the actions summarized in the Department's §862 report describe how DoD can better implement "lifetime" approaches to software talent paths, including training, certifications, and apprenticeships. Of course, it will be important in moving forward to continue to recognize the rapid rate at which software talent can become old and out-of-date, and we encourage DoD to not only use these tools to broaden the skills of the current workforce, but to also help that workforce stay as current as possible. The actions described in the §862 report support this philosophy.

The S&T subcommittee also continues to recognize the importance of recruiting and retaining top talent in addition to providing lifetime education within DoD. In doing so, it is important to remember that goal of improving software training programs within DoD is most often not to enable the Department to build DoD-specific software in-house, but rather to make the right decisions about what software DoD should buy without major customization (adapting its processes to match those of commercial industry), what to develop through partnerships with commercial industry (utilizing integrated DevSecOps practices to release software to the field and in a highly iterative fashion), or what to develop itself (with the best possible people) because there is no other viable option. Software competency is a necessary condition to being a smart acquirer.

In addition to the actions already underway, in our advisory role to DoD, we encourage the Department to build on what they have accomplished and consider going even further, with the support and help of Congress through the following:

- DoD needs a searchable talent database that records software credentials, expertise, and related experiences for software professionals. This database should be designed as a tool to help assemble capable software teams to meet a program's objectives. Engineering and software professionals are not fungible commodities, and as any experienced program manager will tell you, a great engineer is worth more than a dozen good ones. Talent is like a tool: you need to find the right match between the tool and the job. Without a talent database, the Department will continue to underuse its workforce and assemble suboptimal teams.

- In addition to certification, badging, and traditional "educational" approaches, DoD should emphasize and expand additional approaches to improve the workforce, such as the “dojo” method described in the report, as well as apprenticeship programs for software engineering and program management. These methods encourage active learning (learning by doing with a mentor) rather than passive learning (learning through a lecture by an instructor). Software is more akin to a trade skill; the more you do it with great mentorship, the better you get.

- We encourage DoD to consider adoption of a continuous learning model like those practiced in the legal and medical fields. For example, the requirement that lawyers seek out continuing legal education (CLE) credits through a wide range of engagements that practitioners can choose based on their interests and professional requirements is a best practice. Continuing medical education (CME) requirements for doctors serve a similar role.

Overall, the DIB S&T subcommittee finds that the actions described in the Department’s §862 final report are in strong alignment with the key themes and recommendations from the DIB’s Software Acquisition and Practices report and the needs of DoD in moving forward with its ability to make software a critical enabler of military capability in support of national defense.

(8) Section 1723(a)(2) of such title is amended by striking "section 1733 of this title" and inserting "section 1731 of this title".

(9) Section 1725 of such title is amended—

(A) in subsection (a)(1), by striking "Defense Acquisition Corps" and inserting "acquisition workforce"; and

(B) in subsection (d)(2), by striking "of the Defense Acquisition Corps" and inserting "in the acquisition workforce serving in critical acquisition positions".

(10) Section 1734 of such title is amended—

(A) by striking "of the Acquisition Corps" in subsections (e)(1) and (h) and inserting "of the acquisition workforce"; and

(B) in subsection (g)—

(i) by striking "of the Acquisition Corps" in the first sentence and inserting "of the acquisition workforce";

(ii) by striking "of the Corps" and inserting "of the acquisition workforce"; and

(iii) by striking "of the Acquisition Corps" in the second sentence and inserting "of the acquisition workforce in critical acquisition positions".

(11) Section 1737 of such title is amended—

(A) in subsection (a)(1), by striking "of the Acquisition Corps" and inserting "of the acquisition workforce"; and

(B) in subsection (b), by striking "of the Corps" and inserting "of the acquisition workforce".

(12) Section 1742(a)(1) of such title is amended by striking "the Acquisition Corps" and inserting "acquisition positions in the Department of Defense".

(13) Section 2228(a)(4) of such title is amended by striking "under section 1733(b)(1)(C) of this title" and inserting "under section 1731 of this title".

(14) Section 7016(b)(5)(B) of such title is amended by striking "under section 1733 of this title" and inserting "under section 1731 of this title".

(15) Section 8016(b)(4)(B) of such title is amended by striking "under section 1733 of this title" and inserting "under section 1731 of this title".

(16) Section 9016(b)(4)(B) of such title is amended by striking "under section 1733 of this title" and inserting "under section 1731 of this title".

(17) Paragraph (1) of section 317 of title 37, United States Code, is amended to read as follows:

"(1) is a member of the acquisition workforce selected to serve in, or serving in, a critical acquisition position designated under section 1731 of title 10.".

SEC. 862. SOFTWARE DEVELOPMENT AND SOFTWARE ACQUISITION TRAINING AND MANAGEMENT PROGRAMS.

(a) ESTABLISHMENT OF SOFTWARE DEVELOPMENT AND SOFTWARE ACQUISITION TRAINING AND MANAGEMENT PROGRAMS.—

(1) IN GENERAL.—The Secretary of Defense, acting through the Under Secretary of Defense for Acquisition and Sustainment and in consultation with the Under Secretary of Defense for Research and Engineering, the Under Secretary

of Defense for Personnel and Readiness, and the Chief Information Officer of the Department of Defense, shall establish software development and software acquisition training and management programs for all software acquisition professionals, software developers, and other appropriate individuals (as determined by the Secretary of Defense), to earn a certification in software development and software acquisition.

(2) PROGRAM CONTENTS.—The programs established under paragraph (1) shall—

(A) develop and expand the use of specialized training programs for chief information officers of the military departments and the Defense Agencies, service acquisition executives, program executive officers, and program managers to include training on and experience in—

(i) continuous software development; and

(ii) acquisition pathways available to acquire software;

(B) ensure that appropriate program managers—

(i) have demonstrated competency in current software processes;

(ii) have the skills to lead a workforce that can quickly meet challenges, use software tools that prioritize continuous or frequent upgrades as such tools become available, take up opportunities provided by new innovations, and plan software activities in short iterations to learn from risks of software testing; and

(iii) have the experience and training to delegate technical oversight and execution decisions; and

(C) include continuing education courses, exchanges with private-sector organizations, and experiential training to help individuals maintain skills learned through the programs.

(b) REPORTS.—

(1) REPORTS REQUIRED.—The Secretary shall submit to the congressional defense committees—

(A) not later than 90 days after the date of the enactment of this Act, an initial report; and

(B) not later than one year after the date of the enactment of this Act, a final report.

(2) CONTENTS.—Each report required under paragraph (1) shall include—

(A) the status of implementing the software development and software acquisition training and management programs established under subsection (a)(1);

(B) a description of the requirements for certification, including the requirements for competencies in current software processes;

(C) a description of potential career paths in software development and software acquisition within the Department of Defense;

(D) an independent assessment conducted by the Defense Innovation Board of the progress made on implementing the programs established under subsection (a)(1); and

(E) any recommendations for changes to existing law to facilitate the implementation of the programs established under subsection (a)(1).

(c) DEFINITIONS.—In this section:

(1) PROGRAM EXECUTIVE OFFICER; PROGRAM MANAGER.—The terms "program executive officer" and "program manager" have the meanings given those terms, respectively, in section 1737 of title 10, United States Code.

(2) SERVICE ACQUISITION EXECUTIVE.—The terms "military department", "Defense Agency", and "service acquisition executive" have the meanings given those terms, respectively, in section 101 of title 10, United States Code.

(3) MAJOR DEFENSE ACQUISITION PROGRAM.—The term "major defense acquisition program" has the meaning given in section 2430 of title 10, United States Code.

(4) DEFENSE BUSINESS SYSTEM.—The term "defense business system" has the meaning given in section 2222(i)(1) of title 10, United States Code.

SEC. 863. MODIFICATION OF TEMPORARY ASSIGNMENTS OF DEPARTMENT OF DEFENSE EMPLOYEES TO A PRIVATE-SECTOR ORGANIZATION.

(a) PUBLIC-PRIVATE TALENT EXCHANGE PROGRAM.—Section 1599g of title 10, United States Code, is amended by adding at the end the following new subsections:

"(i) CONFLICTS OF INTEREST.—A private-sector organization that is temporarily assigned a member of the acquisition workforce under this section shall not be considered to have a conflict of interest with the Department of Defense solely because of participation in the program established under this section.

"(j) FUNDING; USE OF DEFENSE ACQUISITION WORKFORCE DEVELOPMENT FUND.—Funds for the expenses for the program established under this section may be provided from amounts in the Department of Defense Acquisition Workforce Development Fund. Expenses for the program include—

"(1) notwithstanding section 1705(e)(5) of this title, the base salary of a civilian member of the acquisition workforce assigned to a private-sector organization under this section, during the period of that assignment;

"(2) expenses relating to assignment under this section of a member of the acquisition workforce away from the member's regular duty station, including expenses for travel, per diem, and lodging; and

"(3) expenses for the administration of the program.".

(b) USE OF DEFENSE ACQUISITION WORKFORCE DEVELOPMENT FUND.—Section 1705(e)(1) of such title is amended by adding at the end the following new subparagraph:

"(C) Amounts in the Fund may be used to pay the expenses of the public-private talent exchange program established under section 1599g of this title.".

SEC. 864. INCENTIVES AND CONSIDERATION FOR QUALIFIED TRAINING PROGRAMS.

(a) IN GENERAL.—Chapter 141 of title 10, United States Code, is amended by inserting after section 2409 the following new section:

"§ 2409a. Incentives and consideration for qualified training programs

"(a) INCENTIVES.—The Secretary of Defense shall develop workforce development investment incentives for a contractor that implements a qualified training program to develop the workforce

INITIAL REPORT TO CONGRESS ON FY20 NDAA SECTION 862(B)(1)(A) SOFTWARE DEVELOPMENT AND SOFTWARE ACQUISITION TRAINING AND MANAGEMENT PROGRAMS

Office of the Under Secretary of Defense
for Acquisition and Sustainment

August 2020

The estimated cost of this report or study for the Department of Defense is approximately $58,000 in Fiscal Years 2020 - 2021. This includes $2,400 in expenses and $56,000 in DoD labor.

Generated on 2020 April 03 RefID: 5-B8543A3

A SOFTWARE-CAPABLE DOD WORKFORCE – A STRATEGIC IMPERATIVE

NATIONAL DEFENSE STRATEGY

The 2018 National Defense Strategy (NDS) requires that we modernize key military capabilities to maintain our competitive edge against our adversaries. Software is a critical component of many of the capabilities identified in the NDS, including modernizing the nuclear triad; space and cyberspace warfighting domains; integrating cyber capabilities into the full spectrum of military operations; command, control, communications, computers and intelligence, surveillance, and reconnaissance; missile defense; and advanced autonomous systems. The Department of Defense (DoD) also recognizes the need to transform the acquisition system to improve deployment of software-intensive combat capabilities and supporting systems. DoD relies on its workforce to work effectively with the private sector, through development and acquisition and sustainment, to provide the warfighter hardware and software-reliant operational capabilities efficiently and at the speed of relevance. This requires adopting and adapting modern software development methods and best practices. In 2018, Ellen Lord, the Under Secretary of Defense for Acquisition and Sustainment, stated the degree to which software drives our world demands and requires a move toward a modern tech company model for software delivery: "As we reorganize the way we do business the thread that runs through all of our programs and all that we do is software and I believe that we need to catch up with the private sector and make sure we are using contemporary software development processes." To modernize key military capabilities, the DoD acquisition community must deliberately develop and sustain a software-capable workforce.

DEFENSE INNOVATION BOARD AND DEFENSE SCIENCE BOARD

The Defense Innovation Board (DIB) examined the state of software challenges in DoD's acquisition programs and observed that software is the most frequent and most critical challenge, driving program risk on approximately 60 percent of acquisition programs. The DIB concluded in its May 2019 report that DoD's current approach to software development is broken.[1] Additionally, the DoD Chief Information Officer (CIO) concluded the same in its 2019 DevSecOps guide which states that "legacy software acquisition and development practices in the DoD do not provide the agility to deploy new software 'at the speed of operations.'" The Defense Science Board's 2018 report, *Design and Acquisition of Software for Defense Systems,* emphasizes that "software is a crucial and growing part of weapons systems and the national security mission, and the DoD must address its ability to build and sustain software continuously and indefinitely." The DIB recommended DoD establish specialized training programs to provide insight into modern software development for CIOs, acquisition professionals, and other appropriate DoD personnel. This recommendation is challenging: in current defense acquisition training and management programs, knowledge of and experience in the fundamentals of modern approaches are in short supply, and acquisition professionals like program managers and contracting officers often have limited familiarity with software and Agile development

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

practices. Existing civilian and military software expertise is scattered throughout the workforce and not systematically identified, tracked, and developed. There are also few career paths available to software acquisition professionals and software developers within the DoD and the Services; therefore, there is minimal room for job growth and little incentive for talented software developers, software engineers, product managers, user experience/user interface (UX/UI) designers, data engineers, etc., to join DoD. As a result, the DoD struggles to attract new talent or take advantage of existing talent, which in turn makes it difficult to identify skill gaps in certain areas and build the new capabilities needed to fill those gaps. These shortfalls add risk to DoD's efforts to deliver quality software capability in a timely manner.

CONGRESSIONAL DIRECTION

Congress has also recognized the need and provided direction to DoD to deliberately develop and sustain a software-capable workforce. Section 862 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020 (Public Law 116-92) directs the Secretary of Defense, acting through the Under Secretary of Defense for Acquisition and Sustainment and in consultation with the Under Secretary of Defense for Research and Engineering, the Under Secretary of Defense for Personnel and Readiness, and the Chief Information Officer of the Department of Defense, to establish software development and software acquisition training and management programs for all software acquisition professionals, software developers, and other appropriate individuals (as determined by the Secretary of Defense), to earn a certification in software development and software acquisition.

Section 862 requires that the Department's established programs develop and expand use of specialized training programs for chief information officers of the military departments and the Defense Agencies, service acquisition executives, program executive officers, and program managers to include training on and experience in— (i) continuous software development; and (ii) acquisition pathways available to acquire software. Additionally, the Department shall ensure that appropriate program managers— (i) have demonstrated competency in current software processes; (ii) have the skills to lead a workforce that can quickly meet challenges, use software tools that prioritize continuous or frequent upgrades as such tools become available, take up opportunities provided by new innovations, and plan software activities in short iterations to learn from risks of software testing; and (iii) have the experience and training to delegate technical oversight and execution decisions. Section 862 also requires that the programs include continuing education courses, exchanges with private-sector organizations, and experiential training to help individuals maintain skills learned through the programs.

DOD IMPLEMENTS ADAPTIVE ACQUISITION FRAMEWORK – SOFTWARE ACQUISITION PATHWAY

On January 3, 2020, Under Secretary Lord strengthened the foundation for moving to modern software acquisition and development in DoD by issuing the Software Acquisition Pathway Interim Policy and Procedures memo as part of the new Adaptive Acquisition Framework (AAF).[2] The AAF is composed of six acquisition pathways, each tailored for the

[2] Information on DoD's Adaptive Acquisition Framework is available at https://aaf.dau.edu/.

unique characteristics and risk profile of the capability being acquired. While software is critical across all AAF pathways, the Software Acquisition Pathway applies specifically to the acquisition, development, operations, and sustainment of DoD software-intensive systems. The key pathway tenets include: simplify the acquisition model to enable continuous integration and delivery of software capability on timelines relevant to the warfighter and end-user; involve end-user early and often in development process to ensure value; establish the software acquisition pathway as the preferred path for acquisition and development of software-intensive systems; establish framework to manage risk and enable successful software acquisition and development; and structure contracts around iterative delivery of capabilities instead of traditional products.

Examples of software intensive systems include software-only systems, such as Command & Control (C2) software or applications; weapon system software, such as Intelligence, Surveillance, and Reconnaissance (ISR) software; embedded mission planning software or embedded Situational Awareness software; and any other custom-developed software running on commercial or modified commercial hardware. Program Managers ensure that software teams use iterative and incremental software development methodologies (such as Agile or Lean), and use modern technologies (e.g., DevSecOps pipelines) to achieve automated testing, continuous integration and continuous delivery of user capabilities, frequent user feedback and engagement at every iteration if possible, robust security and authorization processes, and continuous runtime monitoring of operational software. Additionally, software development teams are required to consider the program's lifecycle objective and use sound software practices to achieve improved software quality (e.g., manage technical debt, actively refactor design and code, and create effective modular open systems approaches to support future capabilities).

DOD IMPLEMENTATION OF TRAINING AND MANAGEMENT PROGRAMS

The USD(A&S) established the DoD Software Workforce Working Group (SWG) in May 2019 to implement the intent of the recommendations of the May 2019 DIB report.[3] The recommendations include guiding the civilian and military workforce in the rapid development and deployment of modern software to the field using DevSecOps practices by working with relevant stakeholders to develop training for acquisition professionals and career paths to recruit and retain acquisition and digital talent. The working group, facilitated by A&S Human Capital Initiatives, includes software and other subject matter experts from the Army, Navy, Air Force, DoD CIO, OUSD (Research & Engineering), OUSD(Personnel and Readiness), Defense Acquisition University (DAU), Air Force Institute of Technology, U.S. Air Force Kessel Run, National Security Innovation Network, Joint Artificial Intelligence Center, and National Security Commission on Artificial Intelligence. With enactment of the FY 2020 NDAA section 862 in December 2019, the SWG assumed responsibility for developing the initial report required by section 862. This report addresses the following section 862 reporting requirements:

A. Status of implementing software development and software acquisition training and management programs established under section 862;
B. Certification requirements, including for competencies in current software processes;
C. Potential career paths in software development and software acquisition within the DoD;

[3] DIB, *Software Is Never Done,* S33-S44 (DIB workforce recommendations, or line of effort "C").

D. An independent assessment conducted by the Defense Innovation Board of the progress made on implementing the programs established under section 862; and
E. Any recommendations for changes to existing law to facilitate the implementation of the programs established under section 862.

A. STATUS OF IMPLEMENTING TRAINING AND MANAGEMENT PROGRAMS

Section 862 requires an initial report that describes DoD's efforts to develop and implement software development and software acquisition training and management programs for DoD software acquisition professionals, software developers, and other appropriate individuals. While this report addresses software specifically, SWG members are providing synergy across related digital and software workforce planning efforts. SWG members are involved in related congressional digital-related workforce planning efforts, including those taken to support the FY 2020 NDAA section 230, "Policy on the Talent Management of Digital Expertise and Software Professionals". Section 230 requires DoD to promote and maintain digital expertise and software development as core competencies in DoD civilian and military workforces by recruiting and retaining individuals with an aptitude in digital expertise and software development. Section 230 also promotes the creation of civilian and military career tracks related to digital expertise, to include the development of training, education, talent management, incentives, and promotion policies. Additionally, SWG members are supporting efforts related to the FY 2020 NDAA sections 255 ("Department-Wide Software Science and Technology Strategy") and 256 ("Artificial Intelligence Education Strategy").

SWG efforts support implementation planning of the intent of the DIB recommendations and section 862. The SWG conducts ongoing interviews with DoD and Service programs, including software developers, program managers, and hiring managers, and software factories that develop and deploy software, federally funded research and development centers (FFRDCs), academic institutions, and industry.[4] These interviews inform the identification of work roles and competencies, existing software training and specific gaps in this training, and workforce challenges and best practices for recruiting, hiring, and retaining software talent. The SWG collects feedback on career paths and existing training for acquisition professionals and software developers. The SWG has reviewed four acquisition career fields (program management, engineering, information technology, and contracting), the DevSecOps Community of Practice, and other communities. Interviews and assessment of career paths and training, in combination with a DoD-wide call for issues and questions, was the focus of a virtual Software Workforce roundtable held and recorded on January 29, 2020. This roundtable was preceded by a Software Pathway virtual roundtable, "Software is Never Done", on January 21, 2020. Both of these roundtables contributed to creation of continuing relationships and a strengthened network between the SWG, Service programs, and software factories across DoD. The SWG is leveraging the network and communities of practice in and outside DoD, to improve understanding of challenges and approaches to meeting software workforce needs and sharing of best practices.

Through the above efforts, the SWG has developed an initial comprehensive inventory of software acquisition and development education and training, internal and external, which are already available to the DoD workforce. Examples of available training include:

[4] In general, a software factory is an organic, Government-led effort to deliver software products to the warfighter.

The Defense Acquisition University (DAU) has made commercial online training licenses available to the acquisition workforce. The private sector training includes training provided by universities and corporations. This training is available free of charge to acquisition organizations. Examples of program offerings include: Agile Development (provided by University of Virginia (UVA) Darden and University of Alberta), Continuous Delivery and DevOps (provided by UVA Darden and University of California Davis), Python programming (University of Michigan, IBM, Rice) and Cloud Computing (Google, Amazon, University of Illinois).

DAU also provides workshops on Agile and DevSecOps, which combine commercial and in-house developed training – an example of existing internal training available. DAU developed and fielded a course "Agile for DoD Acquisition Team Members" which is the basis of a new DAU Agile credential. DAU also teamed with DoD's DevSecOps pioneers to develop and field a "DevSecOps for the DoD" foundations workshop. The workshop provides an overview of how DoD DevSecOps approaches enable the Department's strategy to rapidly deliver secure, reliable software-based capabilities to the Warfighter. This offering features Full-Stack DevSecOps engineers providing a live, hands-on DevSecOps pipeline demonstration showing how automation, modern processes, and tools support continuous delivery of value, and faster feedback.

In addition, DAU supports DoD Information Technology (IT) leaders and the acquisition workforce needs with significant software acquisition management training. The 8,000 acquisition workforce members identified as having IT responsibilities are supported by a joint governance team that maintains workforce enterprise requirements, including certification levels with their own training, continuous learning, and experience requirements. The IT competencies and IT training requirement identified by the governance team include software acquisition management, along with associated training in cloud, cybersecurity, enterprise architecture, defense business systems, among other topics associated with the IT competency set. This training is accessible to the entire DoD acquisition workforce.

The SWG has compiled an education and training inventory of DoD, Service, and commercial (e.g., Amazon, Google, IBM, LinkedIn Learning) offerings. This inventory also includes a list of current DoD and Service exchange programs, commercial experiential training opportunities, relevant communities of practices, and other sources such as books and videos. All of these resources will be considered in the development of training and management programs to make education and training accessible and manageable to the workforce.

B. STATUS OF CERTIFICATION AND COMPETENCY REQUIREMENTS

Section 862 requires a description of the Department's efforts to institute competency and certification requirements for software acquisition professionals and software developers. The SWG work is ongoing and includes defining the workforce, competencies and roles, identifying the workforce, and developing the alternatives for certification and training. The SWG will revise definitions, competencies, and training as needed.

Defining the Workforce

The SWG is developing definitions, identifying software work roles, competencies, and alternatives for standard definitions and competencies, identifying the workforce in those roles, and identifying gaps in current education and training programs. Two roles are specifically recognized in section 862: software acquisition professional and software developer.

To define a software acquisition professional, the SWG must first baseline and understand the roles within of the acquisition workforce and across the execution of acquisition functions. The SWG is conducting analysis through questions such as:

- What is the role of the software acquisition professional?
- What is the role of the software acquisition professional in comparison or relation to the entire acquisition workforce?
- What knowledge, skills, education, experience, and competency does the software acquisition professional require?
- What are the needs of the writ-large acquisition workforce and specific functions/specialties in terms of varying degree of knowledge, skills, education, experience, and competency of modern software development?
- How and where do software developers link through their work and roles into the acquisition workforce?

To define software developers, the SWG is baselining roles and considering questions such as:

- What are the roles for software developers, software engineers, product managers, designers, and other software roles in the workforce?
- How are these roles similar/different and how can the working group use this information to develop a comprehensive definition for these roles?
- How do acquisition professionals tie into the development of software-intensive systems?
- What training is required to ensure their programs succeed?
- How does the private sector categorize software expertise and software competencies?
- Who is performing software functions across DoD components?

Software Competencies

DoD defines "competency" as "an observable, measurable pattern of knowledge, skills, abilities, behaviors, and other characteristics needed to perform work roles or occupational functions successfully."[5] Software competencies include core competencies that apply to all DoD personnel and specific job competencies for software acquisition professionals and developers (defined by the working group), including CIOs, Service Acquisition Executives, Program Executive Officers, and Program Managers. In addition to determining and defining software roles, the SWG has reviewed existing DoD acquisition competencies (e.g.,

[5] *Department of Defense Competency Management Implementation Guide* (2015); DoD Instruction 1400.25, Volume 250, "Civilian Strategic Human Capital Planning," June 7, 2016.

competencies for contracting, financial management, and IT acquisition career fields) and industry standard competency categories, such as the Software Engineering Body of Knowledge (an international standard that describes generally accepted knowledge areas about software engineering), and other private and public sector sources to baseline and then assess variance and whether the competencies can fully or partially address DoD needs. The SWG also reviewed a recent RAND National Defense Research Institute (NDRI) study conducted for OUSD(R&E). RAND NDRI investigated how to improve the ability of the Department to more rapidly and reliability deliver complex software dependent capabilities in three areas. For the first area, RAND developed an initial competency model that emphasized an enhanced understanding of modern software practices and technical competencies. RAND also reviewed training and education offerings at DAU and identified potential gaps in current training. Additionally, RAND provided recommendations for tracking and managing a software acquisition workforce.[6]

An initial set of competencies have been identified; however, additional competencies may be identified during the training gap analysis. The competencies will be validated and revised when needed. The working group will then finalize an approach to identify software acquisition professionals and software developers across the DoD and Services to definitively determine work roles, expand education and training programs, and pre-position individuals into the specialty area who may already possess some but not all of the necessary competencies. The task of identifying the competencies is particularly important because all other efforts (i.e., identifying gaps in training, developing career paths) hinge upon the competencies.

Identifying the Workforce

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. As a result, software developers are hired and identified through multiple hiring authorities and occupational series (e.g., 0854 Computer Engineering, 1550 Computer Science, or 2210 Information Technology). The SWG is leveraging information gathered from programs and software factories and DoD and Service subject matter experts to assess approaches to identifying the workforce. In addition, the working group is leveraging the experience of those working group members who have previously developed methods to identify software expertise, such as in the cyber workforce. The SWG is also exploring a new civilian software family of occupational series through the Office of Personnel Management. Lastly, the SWG is assessing the requirements for new data elements and coding capabilities in DoD's human resources personnel system to

[6] Sean Robson et al., "Software Acquisition Workforce Initiative for the Department of Defense: Initial Competency Development and Preparation for Validation" (Washington, DC: RAND Corporation, 2020), https://www.rand.org/pubs/research_reports/RR3145.html.

account for the software workforce within DoD.

Certification

Defining approaches to certification will follow from the completion of ongoing SWG work on defining the workforce and competencies. Near term, the SWG will identify and communicate training that the workforce can already access and take today based on self-initiative or as part of an individual development plan. The SWG approach includes supporting the success of Services' current service initiatives and leveraging current DAU enterprise resources. The SWG approach also includes assessing and appropriately leveraging commercial standards, certifications, credentialing, and other best practices. In parallel, the SWG's intent is to continue efforts to establish a sound competency-based foundation for any resulting certification framework. The SWG will also develop needed metrics and approaches to ensure managers and the software workforce have easy access to workforce certifications and credentials information. This capability includes ensuring synchronizing with current efforts to modernize talent management and talent management systems for the defense acquisition workforce and other related digital workforce initiatives.

The SWG will provide more details on recommended approaches to certification in the December 2020 report.

C. CAREER PATHS

Section 862 requires a description of efforts to establish career paths in software development and software acquisition within the DoD. The SWG assessment and development of recommended career paths will be informed by its current analysis which includes developing definitions, competencies, workforce identification, training, and certification requirements.

The Department understands that software expertise takes many different forms. It will be a major challenge to ensure that the new career paths take into consideration experiential training, demonstrated capabilities, and on-the-job accomplishments, rather than relying on rigid advancement based on formal education standards, certifications, and years-in-service. There is also the added challenge of ensuring that career paths are cross-cutting and available to all members of the acquisition workforce. Competencies, specialist tracks, and training should be delivered to the primary acquisition workforce (e.g., program management and engineering at a minimum); general competency should be available to support interdisciplinary digital literacy, software knowledge, skills, and abilities across the entire acquisition workforce (e.g., test & evaluation and lifecycle logistics workforce).

Interviews conducted by the working group have reiterated the need for career paths for software acquisition professionals and developers, resources such as mentoring programs, and incentives for remaining within the DoD. As addressed above, the working group is also currently exploring the possibility of creating new civilian software occupational series through the Office of Personnel Management. Should such an occupational series be established, it will significantly simplify the process of identifying, tracking, and building software expertise in the DoD civilian workforce, particularly new recruits, but the DoD will still need to develop a method for identifying and tracking current personnel. Together, these efforts will paint a more

accurate portrayal of the current number and expertise of software acquisition professionals within the acquisition workforce and software developers within the DoD at large.

The DoD is currently considering a functional transformation of the acquisition workforce, which would reduce the number of career fields, allowing the acquisition workforce to develop new expertise and competencies in communities of practice centered on key acquisition issues. Software acquisition will be addressed in the context of how the training, certification, and career development recommendations support the new DoD Instruction 5000 series, Adaptive Acquisition Framework, and which roles meet the criteria for acquisition workforce classification.

The SWG will provide more details on recommended career paths in the December 2020 report.

D. DEFENSE INNOVATION BOARD INDEPENDENT ASSESSMENT

Section 862 requires an independent assessment of this report by the DIB. The DIB, a federal advisory committee that provides advice to the Secretary of Defense, provided an initial assessment of this report at their March 5, 2020, public meeting held at Capital Factory in Austin, TX. Per Federal Advisory Committee Act rules, the DIB must deliberate and approve final findings during a public forum. See Attachment 1 for the DIB's assessment.

E. RECOMMENDATIONS FOR CHANGES TO EXISTING LAW

Section 862 requires the inclusion of recommendations the Department may have for changes to existing law to facilitate implementation. The working group will, if appropriate, make these recommendations in the final report.

SUMMARY

The 2018 NDS requires that DoD modernize key military capabilities to maintain our competitive edge against our adversaries. Software is a critical component of many DoD military capabilities. DoD recognizes that it must create and sustain a software-capable workforce that can effectively partner with the private sector, to provide the warfighter hardware and software-reliant operational capabilities efficiently and at the speed of relevance. Through deployment of the DoD AAF, which includes the new Software Acquisition Pathway, today's Service initiatives such as the Air Force Kessel Run, and joint workforce planning by DoD's Software Workforce Working Group, DoD has put in place the foundation to implement near term-small steps and also the long-term enduring organic software capability within DoD's workforce. DoD will provide the section 862(b)(1)(B) final report to Congress in December 2020.

Fiscal Year 2020 National Defense Authorization Act §862(b)(D)
Defense Innovation Board Assessment: Department of Defense Implementation of Software Development and Software Acquisition Training and Management Programs
5 March 2020

The Defense Innovation Board (DIB), a federal advisory committee that provides advice to the Secretary of Defense, was tasked to conduct an assessment of Department of Defense (DoD) efforts implementing FY20 NDAA §862, targeted at the implementation of software development and acquisition training and management programs. As part of the DoD reporting requirement to Congress, the DIB Science and Technology (S&T) sub-committee reviewed a draft version of the report in February 2020 in order to facilitate deliberations at its public meeting on 5 March 2020, as required by the Federal Advisory Committee Act (FACA) regulations.

The materials provided to the DIB presented a high level summary of the work that the Department is undertaking to implement §862. Given that the Department's report is still in draft form, the DIB's assessment may not fully address the totality of efforts outlined in the final version of the DoD report that will ultimately be delivered to Congress. If necessary, the DIB may update its assessment following completion of the DoD report. The DIB will also conduct an additional assessment on Department implementation of software development and software acquisition training and management programs in December 2020, as required by Congress.

The DIB's initial report on the results of DoD's implementation of §862 recognizes good overall alignment with the recommendations of the 2018 Defense Science Board (DSB) software report and the 2019 DIB Software Acquisition and Practices (SWAP) study. The DIB applauds the establishment of a software workforce working group charged with proposing the creation of new career paths for digital talent by establishing software development as a high-visibility, high-priority career track and increasing the level of understanding of modern software across the acquisition workforce. This is an area of urgent need within DoD, and by forming a working group to recommend changes to DoD leadership, the Department has created a potential mechanism for change, which is a crucial first step.

In the DIB's review of the draft report, it was clear the working group was focused on developing a baseline understanding of the myriad of ongoing activities in the Department, identifying the gaps and pain points that need to be addressed, and establishing a set of definitions for the different sections of the workforce and the types of capabilities that will be required. The actual implementation of the changes directed by Congress are still in a formative stage.

Some specific results that are reported include:

- Compilation of a list of civilian occupational series that might comprise software developers, as a precursor to discussion regarding a new core occupational series (COS); and

- Review of career roadmaps and positions descriptions developed by DoD software programs, the Services, and industry.

The DIB believes these are all good first steps, but obviously represent a small fraction of the progress and effort that will be required to attract, retain and promote digital talent within DoD. In addition, the DIB is cognizant of several education, training and leadership hiring efforts aimed at addressing workforce capabilities in software acquisition. The DIB continues to encourage DoD to work with partners in Congress to seek legislative support for these efforts. This was the approach recommended in the SWAP study and yielded success with the Software Acquisition Pathway.

Most importantly, the DIB encourages the working group to continue their efforts and to identify ways to move toward implementation more quickly. As one approach toward accelerating its efforts, the DIB strongly encourages DoD to take an innovative approach toward transformation as it continues its work on implementation of §862: ***start small and iterate quickly***. This is the same axiom that characterizes the best of modern software innovation cycles and is the cornerstone of the DIB's software acquisition study and recommendations. With some creativity it can be implemented here as well. The DIB encourages DoD to implement a quarterly (or faster) "release cycle" in which the working group makes (modest) recommendations for initial changes that can be tried out within a few units of willing "beta testers". If the changes are successful, then they can be expanded to a larger subset of the Department; if not then they can be "rolled back" with relatively little cost. This approach could be used in establishing initial definitions of the workforce, articulating roles and competencies to map the existing workforce, and creating and testing training and certification programs. Each of these areas are identified in the report as current and proposed areas of study, and we hope that by the final report they will be areas in which multiple iterations of implementation have been tested and adopted.

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION
AND SUSTAINMENT

SEP 02 2020

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: "Back-to-Basics" for the Defense Acquisition Workforce

References:
(a) 10 U.S.C. 1702, Under Secretary of Defense for Acquisition and Sustainment
(b) 10 U.S.C. 1721, Designation of Acquisition Positions and Acquisition Career Fields
(c) Department of Defense Instruction (DoDI) 5000.66, "Defense Acquisition Workforce, Education, Training, Experience, and Career Development Program," 27 July 2017, Change 2, September 13, 2019
(d) Defense Acquisition Workforce Program Desk Guide, July 20, 2017

Personnel development is one of the most important functions of our senior leaders. The National Defense Strategy (NDS) requires increased performance in the Department's acquisition system. To support the NDS, it is imperative that we pivot from the past broad workforce focus and get "Back-to-Basics" (BtB) by streamlining our functional area framework and prioritizing limited training resources for the Defense Acquisition Workforce (AWF) who develop, acquire, and sustain operational capability. Therefore, using reference (a) and (b) authority, and in consultation with the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) and the Service Acquisition Executives (SAEs), I announce the phased implementation of the BtB 21st Century AWF talent management framework, beginning on October 1, 2020 with full deployment by October 1, 2021.

To facilitate developing plans to implement the BtB talent management framework, I am restructuring and consolidating AWF Functional Areas to these six: Program Management, Contracting, Life Cycle Logistics, Engineering, Test and Evaluation, and Business Financial Management/Cost Estimating. Effective immediately, the incumbents of the following positions are the Functional Leaders for the six consolidated functional areas. Each Service Acquisition Executive is requested to designate a counterpart:

- Program Management – Assistant Secretary of Defense (Acquisition), Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD(A&S))
- Engineering – Deputy Director, Engineering, OUSD(R&E)
- Test and Evaluation – Deputy Director, Engineering, OUSD(R&E)
- Contracting – Principal Director, Defense Pricing and Contracting, OUSD(A&S)
- Life Cycle Logistics – Assistant Secretary of Defense (Sustainment), OUSD(A&S)
- Business Financial Management/Cost Estimating – Assistant Secretary of Defense (Acquisition), OUSD(A&S)

Additionally, I authorize the following temporary exceptions to policy contained in Section 7 of reference c:

- The Senior Steering Board (SSB) is renamed the Senior Workforce Group (SWG) and its membership is comprised of the (chair) USD (A&S); USD(R&E); Director, Cost Assessment and Program Evaluation (CAPE); and the Service Acquisition Executives.
- The Defense AWF Workforce Management Group (WMG) is renamed the Workforce Leadership Team (WLT) and its membership is comprised of the (chair) DUSD(A&S); ASD(A), ASD(S); Deputy Director of Engineering OUSD(R&E); Deputy Director, Cost Assessment (CAPE); the Principal Civilian Deputies to the SAEs; President, Defense Acquisition University (DAU); and the Executive Director, Human Capital Initiatives (HCI). Respective Principal Staff Assistants may include Defense Agencies and Field Activities, as required.

The Executive Director, HCI, OUSD(A&S), acting on my behalf, will support the SWG/WLT and lead and facilitate overall implementation of the BtB framework by 1 October 2021. HCI will consolidate Functional Area results and recommendations for WLT's ongoing review. Back-to-Basic outcomes for each Functional Area includes achieving streamlined and restructured certification requirements, identifying prioritized credentials, and providing for continuous learning. HCI will also ensure that references c and d are updated accordingly.

The BtB framework only applies to the Defense Acquisition Workforce. In some areas, there is a broader Department of Defense functional community and leader. We expect those providing leadership for the broader communities to continue.

Ellen M. Lord

DISTRIBUTION:
CHIEF INFORMATION OFFICER OF THE DEPARTMENT OF DEFENSE
UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING
UNDER SECRETARY OF DEFENSE (COMPTROLLER)/CHIEF FINANCIAL OFFICER OF THE DEPARTMENT OF DEFENSE
UNDER SECRETARY OF DEFENSE FOR PERSONNEL AND READINESS
UNDER SECRETARY OF DEFENSE FOR INTELLIGENCE AND SECURITY
DIRECTOR OF COST ASSESSMENT AND PROGRAM EVALUATION
SERVICE ACQUISITION EXECUTIVES
DIRECTORS OF DEFENSE AGENCIES AND FIELD ACTIVITIES

“Best” Practices Learned to Date

Software Workforce Working Group
November 9 2020

Academic, Government, and Industry Best Practices

- Academia, Government, and Industry each have their own unique challenges, but we *can* and *should* work together to adapt the most effective practices from both the public and private sectors…

- As of 20 October 2020, the SWWG has spoken to Amazon BRIDGE, Department of Homeland Security, Deloitte (DoD Public Private Talent Exchangee), Facebook (a future Facebook software engineer at the time), Fiat Chrysler Audi, George Mason University, IBM, Microsoft, Virginia Tech, and Walmart. The SWWG has also spoken to DoD and Service software programs.

- We will continue our engagement with academia, industry, and other agencies but here is what we have learned (and considered) so far…

Innovative Cultures Thrive

- Mission is important! If employees feel like they are part of “something” and working on hard problems, they will be “happy” (recognize that happy is relative)
  - This is especially important for students entering the workplace right out of college
- Employees “own” their own development (flexible training)
- Live and work by “leadership principles”
- “Working Backwards”: If an employee has an idea, they are encouraged to follow the “working backwards” process: write a press release on the futuristic roll-out of the new product or idea; develop a Q&A to solidify thoughts; and write a one pager and then a five pager. All of these products go through “murder boards”; once the product is strong enough, only then (after many iterations) is it submitted to leadership. One current Amazon employee even wrote their own job description based on a concept developed by Air Force Fellows
- Allowing developers to switch projects or teams for a change of pace or to learn something new
  - The relationship between a team member and program manager is VERY important
- All companies developed specific career paths for software professionals; however, there is still flexibility in career progression: let coders remain coders if they do not want to become managers

“Tech” Fluency

- Tech Fluency: “… to engage in and contribute to a tech-driven business environment, to be able to quickly learn the next big emerging technology’s functions, and to grow professionally, **all workers**—from executives to interns—will need to learn much more about critical systems: their capabilities and adjacencies, their strategic and operational value, and the particular possibilities they enable.”
  - There are three levels: basic, intermediate, and advanced

- Business Accelerator: “…brings together various capabilities—business, IT, design—from across SunTrust who work together in ‘accelerator studios’ to deliver solutions for our clients and teammates.”

“Tech” Fluency (Cont.)

- Technological and Engineering Literacy: “The goal is not to make everyone technologists or engineers but to broaden technological and engineering literacy so that people can make informed decisions about technology and better contribute to its design, development, and use.” (ITEEA, 2020 draft, page 1)
  - There are 8 standards (down from 20) core content standards (taught preK-12)

- Nature and Characteristics of Technology and Engineering
- Core Concepts of Technology and Engineering
- Integration of Knowledge, Technologies, Practices
- Impacts of Technology
- Influence of Society on Technological Development
- History of Technology
- Design in Technology and Engineering Education
- Applying, Maintaining, and Assessing Technological Products and Systems

Literacy is a fluid construct, meaning that knowledge, skills, and abilities in a given field will change over time. **Technology** is the modification of the natural environment, through human-designed products, systems, and processes, to satisfy needs and wants. **Engineering** is the use of scientific principles and mathematical reasoning to optimize technologies in order to meet needs that have been defined by criteria under given constraints. **Technological and Engineering Literacy** is the ability to understand, use, create, and assess the human-designed environment that is the product of technology and engineering activity (ITEEA, pages 1 and 3).

Education and Training

- Mandatory Training: Most tech companies the SWWG spoke to have some form of mandatory training, especially in business conduct and security. Career tracks also have specific training.
  - IBM: Under “Think 40,” everyone is required to put in 40 hours of training throughout the year. The training can be whatever is valuable to the position. IBM offers its own recommendations and its own training (the term “learning journeys” is used), but employees can also search outside of IBM for training (some people, for example, use Kubernetes or read books or listen to podcasts on technical topics). Employees just have to keep track of their training and the training has to be reasonable. People are welcome to do more than 40 hours of training, and many do. There is mandatory training that everyone has to take, such as business conduct and low-level security training; the mandatory training also depends on the career track.
  - Microsoft: Mandatory training includes courses on business conduct, privacy engineering, and security. There are different levels of privacy engineering training (engineers who use sensitive data need to take additional courses). Training is mostly on demand (a flexible training plan).

Education and Training (Cont.)

- Third-Party “Universities”: A number of private tech companies have developed “universities” to train and reskill employees
  - Amazon’s AWS Academy
  - Amazon’s Technical Academy (reskills non-technical employees to be software engineers)
  - Amazon’s Machine Learning University
  - Deloitte University
  - Microsoft University
  - Google’s Analytic Academy
- Dojos: An immersive learning experience where full-stack teams learn together and leverage new technology and new ways of working by completing hyper sprints in a six-week period. Each dojo is unique.
  - Platform One recently developed a DoD Dojo

Badging

- IBM Digital Badges: IBM offers badges to make training more fun. Some of the entry-level badges are quick and easy, mere minutes long. Some are an hour or 4-8 hours with a quiz at the end. Some are classroom based, but most are online. Badging helps with promotion.
- Salesforce: Trailhead is a “series of online tutorials that coach beginner and intermediate developers who need to learn how to code for the Salesforce platform. Trailhead education, which was launched in 2014, comes in three levels: trails, modules and units. Lessons are presented in a specific sequence, so customers have a predefined path to follow and a ‘guided, curated’ experience, according to Salesforce.” There is a developer pathway.
- Digital University Badges: There are “badges” for gaining competency in a particular skillset (still being implemented)

Coaching/Mentoring

- Dojos: The premise of dojos is based on coaching, but each company's program is unique

- Deloitte: Offers a robust coaching/mentoring program to advise employees on professional development (offered throughout Deloitte)

- IBM: Provides a strong mentorship program. All new employees are given access to an internal portal where they can select mentors to help them with their career path. There are also coaches who work with employees to identify goals for yearly reviews. There are a number of goal categories, such as client work, consultation, innovation.

Developer Communities

- Software developer/engineer communities provide the workforce with a sense of control and sometimes a place to vent! It is also an opportunity for developers to learn from each other. They have been successful in DoD and in industry…
  - DoD Enterprise DevSecOps Community of Practice is one of the most active
  - IBM: Developers set up an internal developer community, where developers come together weekly to talk about frustrations, provide ideas and solutions, and ask if there is an opportunity to move between teams. This has been invaluable. It gives an employee a feeling of control
  - The IBM Garage has also been very successful. Developers get together to think of innovative approaches to helping businesses get solutions up and running quickly. They use design thinking to determine pain points, and come up with solutions. Developers can usually build a solution within 6 weeks
  - Salesforce: Over 6 million developers are subscribed at https://developer.salesforce.com/!

Recruitment and Internships

- Facebook: Recruits heavily at schools and universities (even specific courses, such as computer science courses, are targeted); Facebook University is a relatively new program that specifically targets underrepresented communities
  - Engineers are also recruited via social media; “handlers” stay with interns through the internship and even help convert interns into other internships/jobs
  - Software engineers want to solve “hard” problems and adapt to challenges (legacy systems do not sound interesting to emerging software engineers); recommended to emphasize these points during job fairs and social media!
- IBM: Hosts job fairs, but jobs are often found via word of mouth
- Microsoft: Interns are provided extensive training specific to Microsoft so there is less training needed if they are eventually hired. The onboarding process is then much faster and former interns/new hires can enter the company focused on their new job and NOT onboarding

“Boomerangs”

- Amazon encourages boomerangs; however, this is also why it is difficult for Amazon employees to participate in longer exchange programs (e.g., DoD Public Private Talent Exchange).
- IBM encourages employees to work for IBM for 5-6 years and then, if desired, to leave; they are always welcome to return. This way, former employees come back and bring with them the skills/ perspectives learned from elsewhere
  - NOTE: IBM prefers people who are working on a contract to stay as long as possible to avoid turnover on projects, so really encourage moving, if desired, around the 5-6 year mark
- Microsoft encourages employees to move around teams and other software companies

Disclaimer and Notes

- Information provided to the SWWG via phone and e-mail (much of the language in this document is pulled from meeting notes). Meetings were mostly conducted in April and May of 2020 so information is subject to change. Individuals provided their own viewpoint and should not be considered official representative of company policies. The SWWG sincerely appreciates their willingness to speak with us.

- Quotes on slide 4 were puled from: Anthony Stephan, Martin Kamen, and Catherine Bannister, “Tech Fluency: A Foundation of Future Careers,” *Deloitte Review* Issue 21 (July 2017), https://www2.deloitte.com/content/dam/insights/us/articles/3877_Tech-fluency/DUP_Tech-fluency-reprint.pdf.

- Salesforce information was pulled from their website and from notes taken during Fedscoop’s 2019 Workforce Summit

APPENDIX E: Draft Software Competency Menu

Objective

Software competencies are defined as the observable, measurable pattern of knowledge, skills, abilities, behaviors, and other characteristics needed to perform software roles or software occupational functions successfully. Competency requirements do vary by role; for example, software practitioners and software acquisition professionals would differ in depth within competencies. To be most applicable to roles and functions across the entirety of the DoD that enable software delivery, the overarching competency topics are broad. The SWWG has been developing these competencies leveraging expertise from industry, particularly the Software Engineering Body of Knowledge, and academia to support, this is an iteration from the draft Software Competencies from June 2020.

Table 1. Software Competency Topics

	Competency Topics	Competency Descriptions
1	Software Foundational Concepts & the DoD	Describe digital services in the 21st century, including what they are, who provides them, how they are delivered, and why they are important--fundamentals of agile and DevSecOps.
2	Capabilities Needs Development/Evolution & User Engagement/Design	The ability to identify stakeholder and translate requirements and establishment of user engagement throughout the entirety of capability development and delivery. User-centric design: Integrating design-thinking, human-centered design, UX/HCI into system development & deployment
3	Software Architecture and Data Management	The ability to plan for long-term maintainability using architectural structures, viewpoints, styles, design decisions and frameworks, and the underlying data structures. Understanding various cloud services, cloud native architecture as well as edge sensing and computing enablers for capability delivery
4	Software Development and Delivery	**Development**: The ability to implement software that minimizes complexity, anticipate change, plan for verification, reuse software, use coding standards and **Delivery**: Continuous Integration and Continuous Delivery (CI/CD) using modern software practices
5	Acquisition Technical Expertise and Change	Effectively use techniques for acquiring digital service solutions in your solicitation or acquisition strategy

Detailed Software Competency Menu

Competency Topics	Competencies	Knowledge Area	Knowledge Skills
Software Foundational Concepts & the DoD	**Digital Services**	**Strategic Planning and Change Management**	• Take a long-term view and build a shared vision with others. • Act as a catalyst for organizational change by influencing others to translate strategic planning into action and apply change management principles, strategies, and techniques needed to effectively plan, implement, and evaluate change in the organization. • Develop an understanding of the impacts that change may have on people, processes, procedures, leadership, and organizational culture and the impacts that organizational culture and generational conflict may have on the ability to achieve change. • Develop clear lines of escalation, in agreement with senior managers
		Digital Services in the 21st Century Government	• Describe digital services in the 21st century, including what they are, who provides them, how they are delivered, and why they are important
		Innovation and Entrepreneurship	• Provide transformational solution-based approaches to problem solving and building products by employing an Iterative process of empathize, define, ideate, build/prototype, and test; and institute a culture that encourages early and continuous learning. • Software Engineering Management Tools: Ensure any stakeholder can easily find out an accurate and current project or program status, without disruption to

			delivery
		Feasibility Analysis	• Develop a clear description of project objectives and evaluate alternative approaches in order to determine whether the proposed project is the best alternative given the constraints of technology, resources, finances, and social/political considerations.
		Cost Management	• Implement plans for development, purchase or sustainment; and manage the cost of the acquisition against constraints in scope, schedule, and policy. • Monitor actual software production metrics versus labor and material expenditures, and update effort estimates and cost baselines as needed. Utilize cost management reserve to mitigate development risks.
	Software Management	**Lifecycle Management**	• Evaluation of life cycle, methods, processes, and tools against program outcomes • Quantitative and qualitative measures • Retrospective reviews
Capabilities Needs Development/ Evolution & User Engagement	**Capabilities Elicitation, Capture, and Evolution**	**Software Requirements Fundamentals**	• Definition of a Software Requirement • Defining features and capabilities • Product and Process Requirements • Functional and Non-Functional Requirements • Emergent Properties • Quantifiable Requirements • System Requirements and Software Requirements

		User Engagement	• Design Thinking • Abstraction of user needs through interviews, focus groups and surveys • Effectively communication with users or user representatives • Translation of technical jargon into language relevant to the user's operating environment
		Elicitation Practices	• Applying and managing processes • Identifying stakeholders • Engaging stakeholders in elicitation • Using appropriate methods to capture information • Negotiating conflicts among stakeholders during elicitation • Translating user needs into software features and technical constraints
		Representing and Managing Capabilities	• Iterative aspects of software capability definition and change management • Notations for describing requirements, user stories, and other representations • Capturing and measuring key attributes • Trade-offs • Use / abuse case modeling • Writing user stories • Applying traceability • Validation & Verification • Managing the backlog
		Definition of Done	• Ability to define conditions or acceptance criteria for a software product sufficient to indicate when work is ready for evaluation and acceptance by the user

Software Architecture and Data Management	**Architecture & Design**	**Software Design Fundamentals**	• Enabling techniques (such as abstraction, coupling/cohesion, information hiding, and so forth) in software design • Exception handling and fault tolerance techniques in software design • Restructuring / refactoring methods • Design techniques in the areas of concurrency, event handling, data persistence, or distributed software • General design concepts • Software Design Process • Context of Software Design • Software Design Principles • Documentation of design and design rationale
		Software Structure and Architecture	• Planning for Long-term Maintainability • Architectural Structures and Viewpoints • Architectural Styles • Architecture Design Decisions • Families of Programs and Frameworks
		System Considerations	• Software design in the context of system-of-systems • Software design in the context of embedded systems system-of-systems
		Software Design	• Data Structures • Design Patterns • Microservices • Concurrency • Control Handling of events • Data Persistence • Distribution of Components

			• Error and exception Handling and Fault tolerance • Interaction and Presentation • Designing for Security • API Design • Interface Design • Database design
		Software Design Quality Analysis and Evaluation	• Quality Attributes • Quality Analysis and Evaluation Techniques • Performance Measures
		AI/ML	• Architectural components, methods processes • Training and learning • Data Analysis • Risks of incorporating AI in cyber-physical systems • Automated and augmented decision support • Deep Learning and Neural Networks • Computer Vision • Correctness, trust, transparency, explainability, privacy, availability, safety
	Infrastructure Engineering	**Infrastructure Engineering Fundamentals**	• Infrastructure as Code • Infrastructure Automation • Infrastructure and Application Orchestration • Technical monitoring • Performance management

			• Capacity and availability management • Reliability engineering • Cloud • Containerization • Container Orchestration
	Domains	**Embedded Systems**	• Real-time computing • FPGA/GPU programming • Hardware/software co-development • HW obsolescence mitigation • Managing asynchronous hardware and software development cycles • Digital Twin • HWIL environments and test harnesses
		Safety Critical Systems	• Formal methods, processes, tools and safety standards (D-178C) • Fault Tree Analysis • Hazard identification, mitigation, and removal
		Cloud-native and Mobile	• Webscale computing • Mobile computing • Edge and Fog computing • Data fusion • Denied, Delayed, Intermittent, Latent (DDIL)
		Emerging Technologies	• Maintain understanding of emerging tech and implications on organizational needs, solutions and processes • Research new technologies, approaches, and tools to support next generation software development

			• Tech maturity and adoption readiness analysis • Evaluation of risk/reward in rapid integration of emerging tech into systems • Evaluation of tech ability to disrupt National Security, opponents, allies, external systems, and product architectures
Software Development and Delivery	**Development**	**Software Implementation Fundamentals**	• Minimizing Complexity • Anticipating Change • Planning for Verification • Reuse • Coding Standards • Effort / cost estimation
		Coding Skills	• Code structure • Coding • Programming Languages • Programming Testing • Programming for Reuse • Programming with Reuse • Programming Quality • Software Integration
		Practical Considerations	• The ability to recognize and develop highly readable and maintainable code • Utilizing tech stacks • Managing tech stacks • API implementation • Ability to implement design patterns
		Software Documentation Management	• Documenting software engineering considerations as appropriate for context • Maintaining versioned repositories for

			design, code, and test artifacts • Continuously updating and revising of documentation standards
		Programming Technologies	• Object-Oriented Runtime Issue • Parameterization and Generics • Assertions, Design by Contract, and Defensive • Programming • Error Handling, Exception Handling, and Fault Tolerance • Executable Models • State-Based and Table-Driven Construction Techniques • Runtime Configuration and Internationalization • Grammar-Based Input Processing • Concurrency Primitives • Middleware • Construction Methods for Distributed Software • Constructing Heterogeneous Systems • Performance Analysis and Tuning • Platform Standards • Test-First Programming
		Problem Solving/ Debugging	• Debugging tactics • Interactive debugging • Control flow analysis • Log file analysis • Monitoring at the application or system level • Memory dumps

			• Profiling
		Software Programming Tools	• Development Environments • GUI Builders • Unit Testing Tools • Profiling, Performance Analysis, and Slicing Tools
	Continuous Integration / Continuous Delivery	**Automated Test and Continuous Integration**	• Continuous integration methods, processes, and tools • Test case writing against completion criteria (for each release, capability, microservice, or component) • Continuous integration processes for development • Build Automation • Software Build Process
		Configuration Management and Version Control	• Strategies for identifying and managing the configuration throughout the lifecycle of: - the system and software development and test environment(s), - design, test, and analysis artifacts (including documentation) - the software itself - external dependencies such as associated systems, the underlying hardware and software stack

		Release Planning	• Completion criteria for each release and/or software development iteration • Identification of software items that could benefit from rapid delivery into operations • Adverse impacts of incorrect or unstable software • Planning strategies to accommodate (1) expected and unexpected changes in the dependencies of the operational environment, including emergent security threats or supply chain issues, and (2) addressing technical debt buildup.
		Release Management	• Verification steps for each release to higher levels of integration testing, certification activities, and/or operations. • Testbeds, modeling and simulation to synchronize software releases with the development of and operations environment(s) as needed to ensure compatibility. • Continuous improvement of release planning procedures in response to changes in program needs.
		Deployment	• CI/CD Pipeline development and use (DevSecOps toolchain) • Release Automation • Software Release Management, especially to multiple sites • Roll-back planning and execution • Field defect collection / resolution processes • Support / help desk

	Testing	**Software Testing Fundamentals**	• Testing-Related Terminology • Relationship of Testing to Other Activities • Faults vs. Failures • Test Planning • Test Selection Criteria / Test Adequacy Criteria (Stopping Rules) • Test Documentation • Test Coverage • Automated Testing
		Software Assurance Management	• Methods, processes, and tools needed to assure the integrity of the software • Coding standards • Static and dynamic analysis rules • Test code coverage • Fuzz testing standards • Corrective actions to be taken when code or test standards are not met, and/or when analysis rules are violated. • Tracking of assurance activities • Systematic monitoring, review, reporting, and, when appropriate, revision of the test approach.
		System Integration and Testing	• System Integration and Test Practices

		Test Techniques	• Input Domain-Based Techniques • Code-Based Techniques Peer Reviews • Fault-Based Techniques • Usage-Based Techniques • Model-Based Testing Techniques • Techniques Based on the Nature of the Application • Selecting and Combining Techniques • Functional and Structural • Deterministic vs. Random • UI / HCI Testing • Performance Testing • Stress Testing
		Test-Related Measures	• Evaluation of the Program Under Test • Evaluation of the Tests Performed
	Quality Engineering	**Software Quality Fundamentals**	• Software Engineering Culture and Ethics • Value and Cost of Quality • Models and Quality Characteristics • Software Quality Improvement • Software Safety • Software Quality Tools • Coding Standards • Risk management • Strategic risk / reward analysis
		Quality Assurance	• System / software reviews and audits • Supply chain reviews and audits (across all sub-tiers) • Team, program, and stakeholder metrics

			to assess ability to meet acceptance criteria • Independent quality assessments
		Root Cause, Corrective Action Expertise	• Program and software metrics • Early indicators of adverse trends • Root cause determination
		Software Quality Management Processes	• Software Quality Assurance • Verification and Validation • Reviews and Audits
		Software Quality Practical Considerations	• Software Quality Requirements • Defect Characterization • SQM Techniques Software Quality Measurement
		Security Engineering	• Building In Security • Static security analysis tools • Dynamic security analysis • Penetration testing • Zero Trust model Risk Management Controls
Software Product Management	**Team Management**	**Personnel Management**	• Managing teams, assigning work to teams • Reviewing progress against plan • Corrective action Productivity Incentives
		Work estimation	• Software estimation approaches • Parametric, historical comparisons (analogies) • Bottom-up effort estimates • Business case development

		Roadmap and Schedule Management	• Analysis and planning for schedule dependencies • Schedule / roadmap development
		Software metrics	• Metrics and measures of software scope, cost, schedule, and quality • Quantitative methods (e.g.,statistical control) • Measures of progress against quality goals • Measures of progress against development baselines (e.g. planned versus actual features deployed) • Measures and telemetry of DevSecOps pipeline throughput, stability, security, and value delivered. Personnel Turnover.
	Product Design	**Product Design**	• Frontend Design Skills • Understanding Domain • UX / UI / Prototyping • Framing • Human Centered Design • Product Strategy / Lean and Agile
		Approaches to Design Development	• Agile Methodologies • Facilitation • Visual Design • Leadership Without Authority • Collaboration and Team Building • Vision, Strategy, Roadmaps • Model-based design
Software Acquisition	**Digital Services**	**Understand What You Are Buying**	• Determine the problem to be solved while effectively supporting and

Technical Expertise and Change	**Procurement**		communicating with the customer and industry
		How do you buy	• Effectively use techniques for acquiring digital service solutions in your solicitation or acquisition strategy
		Awarding & Administering Digital Service Contracts	• Conduct and award digital service contracts, using and applying metrics and incentives appropriately, and applying proper course correction when necessary • Work effectively with other suppliers and agencies • Software data rights & IP • Apply best tools and techniques to: team roles, behaviors, structure and culture, agile ceremonies and practices, knowledge transfer and sharing, program management, cross-team coordination, and overall governance of digital service delivery • Determining Closure: An entire project, a major phase of a project, or an iterative development cycle reaches closure when all the plans and processes have been enacted and completed. The criteria for project, phase, or iteration success should be evaluated. • Closure Activities: Closure occurs when the specified tasks for a project, a phase, or an iteration have been completed and satisfactory achievement of the completion criteria has been confirmed. • Reviewing and Evaluating Performance: Use of various methods, tools, and techniques to conduct periodic performance reviews. • The process being used by the project should also be systematically and

			periodically assessed for relevance, utility, and efficacy in the project context. Where appropriate, changes should be made and managed. • Determining Satisfaction of Requirements: Progress should be assessed on achievement of major project milestones (for example, completion of software design architecture or completion of a software technical review), or upon completion of an iterative development cycle that results in a product increment. Variances from software requirements should be identified and appropriate actions should be taken. • Effort, Schedule, and Cost Estimation: The estimated range of effort required for a project, or parts of a project, can be determined using a calibrated estimation model based on historical size and effort data (when available) and other relevant methods such as expert judgment and analogy.
		Leading Change as a Digital Acquisition Professional	• Apply techniques to create a culture of innovation within your sphere that enables you and others to effectively lead and influence customers to the best solutions • Embed an agile culture using techniques from a wide range or agile and lean methodologies and frameworks, but be methodology agnostic • Help to create an open and trust-based environment, which enables a focus on delivery and facilitates continuous improvement • Assess the culture of a team or organization and delivery processes in place to identify improvements and

			facilitate these improvements with the right type of support
		Detailed backlog management	• Maintain a list of capabilities to be developed (aka, the product backlog) and the tasks that are required to realize those capabilities mapped to the release plan. • Add tasks as they are identified throughout the life cycle, including tasks to resolve defects found during design, code, test, and operations.
		Program Measurement	• Establish and Sustain Measurement Commitment • Plan the Measurement Process • Perform the Measurement Process • Evaluate Measurement
		Reporting	• At specified and agreed-upon times, progress to date should be reported—both within the organization (for example, to a project steering committee) and to external stakeholders (for example, clients or users). • Reports should focus on the information needs of the target audience as opposed to the detailed status reporting within the project team.
		Resource Allocation	• Equipment, facilities, and people should be allocated to the identified tasks, including the allocation of responsibilities for completion of various elements of a project and the overall project.

APPENDIX F: Incorporation of Software Competencies into the Engineering and Technical Management (ETM) Functional Area

Objective

Software development proficiency is critical for the ETM functional area given the high likelihood that acquisition personnel in this field will fill key roles in a software program office. The ETM Task Force Working Group, comprised of OSD functional and specialty area representatives and Component representatives, agreed and included software competencies, derived from the competency menu in Appendix E, as part of the Tier 2 core readiness competencies for all ETM personnel. In addition to competencies for the entire ETM functional area, the group determined specialty competencies, at Tier 3, for personnel to achieve higher proficiency in areas such as Software Engineering. See Figure 1 for details about the competency tiers. The Department expects that software competencies will not remain static but will respond to changes in the commercial software development arena and the corresponding needs of the software workforce. The final ETM competency model is still in development.

Figure 1: DoD Five-Tiered Competency Framework

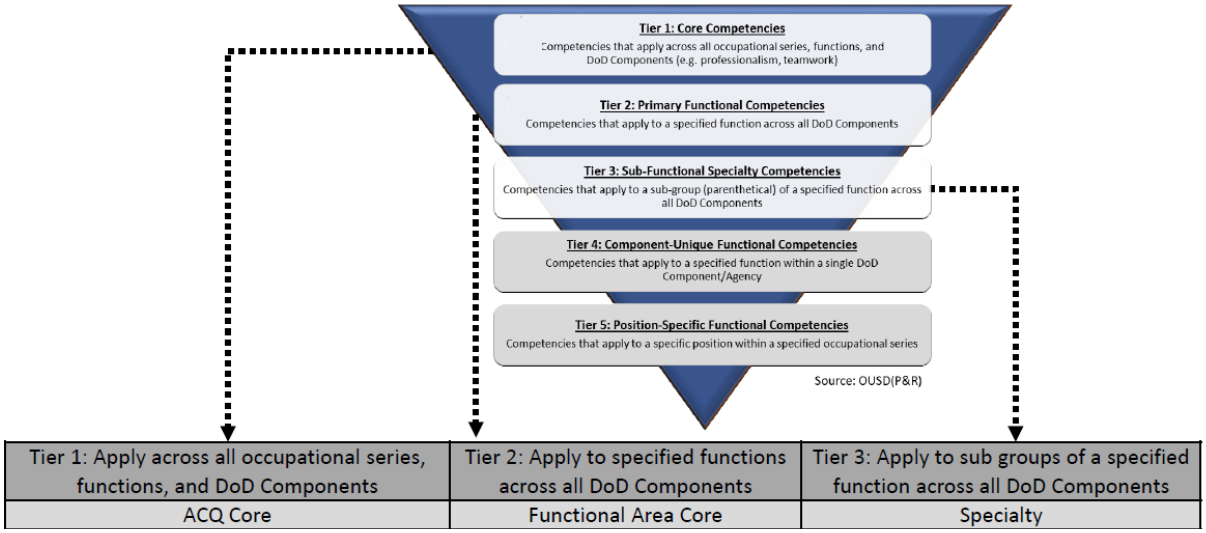


Table 1: Competencies Used to Inform ETM Tiers 1-3

Competency	Notional Definition
Requirements Analysis	Evaluate stakeholder and derived requirements (including constraints) and transform those requirements into a functional and technical view of a system capable of meeting the stakeholders' needs. Decompose needs and constraints into clear, achievable, and verifiable high-level requirements. As the system design evolves, allocate and derive requirements to the system elements and enabling system elements (hardware and software) to be designed and developed.

Architecture Design	Translate the outputs of the Stakeholder Requirements Definition and Requirements Analysis processes into a system architecture baseline that satisfies the documented requirements for hardware, software, and human elements; their enabling processes; and related internal and external interfaces. Synthesize alternative design solutions by considering requirements and constraints, identifying and defining interfaces and system elements (hardware and software), and establishing design budgets (e.g., weight, reliability). Generate architecture and final design based on analysis of alternative designs
Implementation	Ensure the fabrication or creation of a system element (hardware or software) conforms to that element's detailed design and requirements.
Integration	Ensure the systematic assembly of lower-level system elements (hardware and software) into successively higher-level system elements to realize the complete system.
Product Verification	Generate evidence that the system or system element (hardware or software) performs its intended functions and meets all performance requirements listed in the system performance specification and functional and allocated baselines. Apply methods to verify performance, which may include the use of modeling and simulation, and developmental test, including Integrated Testing.
Product Validation	Generate objective evidence that the capability provided by the system complies with stakeholder performance requirements in its intended operational environment.
Product Transition	Advance the system elements to the next level in the physical architecture or provide the end item to the user after ensuring integration with other systems and interface management, both internal and external, for use in the operational environment to include deploying the technical product into production, test, operations and sustainment.
Critical Safety Item (CSI).	Assess and design system elements and/or enabling system elements (hardware and software) to prevent the catastrophic or critical consequences of their failure. Identify and avoid CSI hazards through mitigating receipt of defective, suspect, improperly documented, unapproved, and fraudulent parts in compliance with the statutory requirements. (Section 802 of Public Law 108-136, enacted to address aviation CSIs, and section 130 of Public Law 109-364, enacted to address ship CSIs, embedded in section 2319 of title 10, United States Code)
Open Systems Architecture (OSA)	Assess, design, and implement OSAs to produce modular, interoperable systems allowing system functions or elements to be added, modified, replaced, removed, and/or supported by different vendors throughout the life cycle in order to afford opportunities for enhanced competition and innovation.

Supportability	Identify and mitigate the supportability life-cycle cost drivers in system design (both hardware and software) to ensure a system is affordable across the life cycle.
System Security Engineering	Apply and execute the appropriate systems engineering to integrate security and system security engineering disciplines (including supply chain risk management, cybersecurity, hardware assurance, software assurance, anti-tamper, and exportability protections) to meet program protection requirements and objectives across all levels and phases of an acquisition program. Identify the program's critical program information and mission-critical functions and components and ensure that they are secure through an analysis of threats to and vulnerabilities of these items. Design and apply protection measures to mitigate system security risks while planning for exportability. Includes the ability to build-in security, use static security analysis tools, and conduct dynamic security analysis and penetration testing using a zero-trust model.
Configuration Management	Establish and maintain consistency of a product or system's attributes with its requirements and evolving technical baseline over its life cycle. Includes the ability to develop strategies for identifying and managing the configuration throughout the lifecycle of the system and software development and test environment(s), design, test, and analysis artifacts (including documentation), the software itself, external dependencies like associated systems, and the underlying hardware and software stack
Data Management	Apply policies, procedures and information technology to plan for, acquire, access, manage, protect, and use data of a technical nature to support the total life cycle of the system.
Interface Management	Identify and define internal and external system interfaces (physical and functional). Ensure all internal and external interface requirements are properly documented and controlled.
Software Engineering Management	Execute software acquisition, development and sustainment planning, execution monitoring and delivery, ensuring software performance and development risks are evaluated and managed as part of the program risks; integrate software engineering design analysis, test and demonstrations within the program's systems engineering processes and acquisition documentation throughout all life cycle phases; select appropriate software processes and lifecycle methodology and evaluate software architecture with consideration for software technology trade-offs; determine software's impacts on overall system; and employ best practices in software estimation and measurement of cost, schedule, performance, and maturity.
DevSecOps	Knowledge of DevSecOps methodologies, including interface to documentation and production requirements.
Evolving Technology Threats	Knowledge of methods to understand evolving technology threats (cyber, physical, technological, etc.)

Disruptive Technologies	Maintain, expand knowledge of disruptive technologies affecting DoD capability development
Capability Planning	Analyze IT capability documents to ensure a clear understanding of the initial Product Vision which can change over time.
IT Measurement and Analysis	Develops and implements an IT measurement program that satisfies the unique IT system development and sustainment decision information requirements for a given acquisition program or enterprise.
Software Metrics	The ability to develop metrics and measures of software scope, cost, schedule, and quality, establish quantitative methods, measures of progress against quality goals, measures of progress against development baselines (e.g. planned versus actual features deployed) and measures and telemetry of DevSecOps pipeline throughput, stability, security, and value delivered.
Infrastructure Engineering Fundamentals	The ability to establish infrastructure as code and automation, orchestrate applications, conduct technical monitoring, performance management, capacity and availability management, reliability engineering using tools such as the cloud and containerization functions.
Digital Services in the 21st Century	The ability to describe digital services in the 21st century, including what they are, who provides them, how they are delivered, and why they are important.
Detailed Backlog Management	The ability to maintain a list of capabilities to be developed (aka, the product backlog) and the tasks that are required to realize those capabilities mapped to the release plan including those that are identified throughout the life cycle (defects during design, code, test, and operations).
Lifecycle Management	The ability to evaluate life cycle, methods, processes, and tools against program outcomes using quantitative and qualitative measures and retrospective reviews.
User Engagement	The ability to use design thinking skills, creating an abstraction of user needs through interviews, focus groups and surveys and effective communication with users or user representatives
Elicitation Practices	The ability to identify stakeholders, the process of elicitation from stakeholders using appropriate methods to capture information and translating user needs into software features and technical constraints.
Definition of Done	The ability to define conditions or acceptance criteria for a software product sufficient to indicate when work is ready for evaluation and acceptance by the user.
Software Requirements Fundamentals	The ability to capture a software requirement, features and capabilities including product, process, functional, non-functional, quantifiable, and system requirements.
Software Structure and Architecture	The ability to plan for long-term maintainability using architectural structures, viewpoints, styles, design decisions and frameworks.

System Considerations	The ability to design software in the context of system-of-systems and embedded system-of-systems.
Software Implementation Fundamentals	The ability to implement software that minimizes complexity, anticipate change, plan for verification, reuse software, use coding standards and estimate effort.
Automated Test and Continuous Integration	The ability to use continuous integration methods, processes, and tools in developing and deploying software including test case writing against completion criteria (for each release, capability, micro-service, or component), build automation and build processes.
Software Testing Fundamentals	The ability to understand test-related terminology, the relationship of testing to other activities, understand faults vs. failures, conduct basic test planning, develop test selection or adequacy criteria, craft test documentation, ensure test coverage and conduct automated testing.
Release Planning	The ability to develop completion criteria for each release and/or software development iteration, identify software items that could be rapid delivered into operations, assess adverse impacts of incorrect or unstable software and conduct planning strategies to accommodate (1) expected and unexpected changes in the operational environment, including emergent security threats or supply chain issues, and (2) addressing technical debt buildup.
Release Management	The ability to verify steps for each release to higher levels of integration testing, certification activities, and/or operations using testbeds, modeling and simulation to synchronize software releases with the development of an operations environment(s) to ensure compatibility. Includes the continuous improvement of release planning procedures in response to changes in program needs.
Practical Considerations	The ability to recognize and develop highly readable and maintainable code, utilize and manage tech stacks and implement APIs and design patterns.
Product Design	The ability to design frontends, understand domains, prototype UX / UI designs, frame the product, implement human-centered design and develop a product strategy.
Software Programming Tools	The ability to us development environments, GUI builders, unit testing tools, profiling, performance analysis, and slicing tools.
Roadmap and Schedule Management	The ability to analyze and plan for schedule dependencies and develop a schedule and roadmap.
Software Data Rights & IP	The ability to identify and craft government requirements for rights to the necessary aspects of the software that enable long-term maintenance of the system.
Leading Change	The ability to apply techniques to create a culture of innovation within your sphere that enables you and others to effectively lead and influence customers to the best solutions including embedding a culture using techniques from a wide range or agile and lean

	methodologies and frameworks that creates an open and trust-based environment and focuses on delivery and continuous improvement.
Estimation	The ability to use software estimation approaches, parametric, historical comparisons (analogies), bottom-up effort estimates as well as conducting a business case analysis.
Understand What You Are Buying	The ability to determine the problem to be solved while effectively supporting and communicating with the customer and industry.
Software Pipeline	The ability to configure a CI/CD pipeline development environment using release automation and management, planning and execution of roll-backs, collection and resolution of field defects and provision of a support function or help desk.

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

APPENDIX G: Current Software Training Inventory as of 4 November 20

List of Programs

Air Force Education with Industry
Air Force Institute of Technology
Airmen Coders
AFVentures
Alison
Amazon
Army Futures Command
Army Training with Industry
BESPIN (U.S. Air Force)
Carnegie Mellon University
Construx
Coursera
Cyber IT Exchange Program
Dcode
Defense Acquisition University
Defense Innovation Board
Department of Energy
Department of Homeland Security
Digital.Gov
Department of Defense Enterprise DevSecOps Community of Practice
Dojo DoD (U.S. Air Force)
edX
Enterprise Software Initiative
Federal Acquisition Institute
Federal Coaching Network
Galvanize
General Assembly
General Services Administration (18F)
George Washington University
Google
Harvard
IBM
Institute of Electrical & Electronics
Johns Hopkins University
Kessel Run (U.S. Air Force)
Lambda School
LinkedIn Learning
Linux
Linux Foundation
Marine Coders
Massachusetts Institute of Technology
Microsoft
MITRE
National Centers of Academic Excellence in Cyber Defense
National Defense University
Naval Postgraduate School
NavalX (U.S. Navy)
Navy Training with Industry
openSAP
Open University
O'Reilly Media – Technology & Business Training
Platform One (U.S. Air Force)
Pluralsight
Public Private Talent Exchange (DoD)
QAI-eLearning
Quantum Leap (U.S. Army)
Salesforce
SCRUM Alliance
SecDef Fellows
Software Engineering Institute
Stanford University
Supra Coders (U.S. Space Force)
The Software Alliance (BSA)
University California, Berkeley
Udacity
Udemy
University of Maryland
U.S. Digital Services (TechFAR Hub)
U.S. Naval Community College
U.S. Space Force

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

I. Purpose

This software acquisition and software development education and training inventory is a product of the Department of Defense's (DoD) software workforce working group in response to section 862 of the Fiscal Year 2020 National Defense Authorization Act. The purpose of this document is to (1) provide an initial catalogue of software acquisition and software development education and training and (2) use the resources in this document to identify initial gaps in existing training and determine which programs can be leveraged and what, if any, new programs need to be developed. Ultimately, the software competencies and the training programs will be mapped to career paths for software acquisition professionals and software practitioners. This document is not intended to be all inclusive nor does it endorse any of the resources.

The topics were selected by reviewing the proposed software competencies and the potential software career paths identified by the software workforce working group in response to section 862. Topics were also selected from feedback received in advance of the software training roundtable held on 29 January 2020. Comments included recommendations from DoD civilians and service members on topics that should be improved upon or included in training. Additionally, the software workforce working group provided significant input.

The document includes a variety of different learning opportunities: in-person, virtual, and blended learning; exchange programs; internships; certifications, credentials, and badges; communities of practice; and other resources such as books and videos. The resources were identified by the following methods: incorporating programs already recognized by software workforce working group members, including academic, commercial, and DoD and Service offerings; collaborating with commercial industry companies and other federal agencies; and conducting an online key word search. Information provided below was pulled from various sources such as notes from meetings; materials provided to and by the SWWG; and organization websites.

With regards to the key word search, there was a focus on identifying more affordable offerings; most private software consulting services, some of which are very expensive, were not included unless a software workforce working group member was familiar with the organization. Two and four-year undergraduate and graduate degree programs, including Service Academies, and were also not included for this iteration. These resources are extremely important and valuable; however, this inventory primarily includes short courses and programs to determine what is available to the workforce now as opposed to the near future. Based on discussion between software workforce working group members, these resources may be included in later versions.

Please note that changes to courses and programs can occur daily so information is always subject to change. This is a living document that will continue to be updated.

II. Subject Matter

A. AGILE

Air Force Institute of Technology

- Agile Software Development Workshop

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

    - 1.5 days
    - Covers Agile/some DevOps, particularly in an embedded weapons system
- SENG 593 - Agile Software Systems Engineering
    - IN PERSON/ONLINE (offered online once a year); offered Fall, Winter, and Summer (tuition and cost is available here)
    - Introductory course for experienced engineers
    - The course is part of a graduate program in Systems Engineering, but once a year they offer it via distance learning and it is open to anyone in the DoD to take.
        - This course will provide a foundation for System Engineers to design and architect software intensive systems. Topics include requirements elicitation, object-oriented modeling including the use of the Unified Modeling Language (UML), design patterns, engineering reliable and reusable systems, iterative development, DoD/AF software guidance, case studies, software management best practices and software estimation. The unique challenges faced by teams when engineering large-scale software-intensive systems (i.e., systems which have a large software component) are explored. This course is an introduction to software engineering technical management for experienced engineers whose area of expertise is outside computer science. Outcomes will enable students to more effectively communicate with users and software developers and make sound management and engineering decisions.

Defense Acquisition University

- ISA 1011 - Basic Information Systems Acquisition
    - ONLINE: Approximately 12 hours
    - BEGINNER
    - Module 4: Transformation from waterfall to Agile software development
    - Added modules that focus on software topics (deployed in March 2020)
- ISA 201-Intermediate Information Systems Acquisition
    - CLASSROOM: Approximately 75 hours (has content on Agile software)
    - INTERMEDIATE
- ISA 301-Advanced Enterprise Information Systems Acquisition
    - CLASSROOM: 4.5 days
    - ADVANCED
    - Emphasizes critical thinking for DoD Enterprise IT/SW, includes topics on Agile culture. Speakers from industry are also invited to speak.
- CLE076 Introduction to Agile Software Acquisition
    - ONLINE: Approximately 5 hours to complete
    - BEGINNER
- ACQ 1700 – Agile for DoD Acquisition Team Members

Construx

- IN PERSON AND ONLINE TRAINING: FREE AND NOT FREE
- Construx offers both free and not-free training and consulting resources
- Free Agile webinars and other Agile resources are available here; all other training resources, including for Agile, are available (virtual/in person and self-paced) here

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Coursera

- ONLINE: NOT FREE (DAU possesses a license for Coursera)
- Coursera offers over 100 beginner, intermediate, and advanced classes in Agile
    - 74 BEGINNER courses
    - 26 INTERMIEDIATE courses
    - 2 ADVANCED courses
    - 35 MIXED levels of experience

edX

- ONLINE: 6 weeks (FREE)
- ETH Zurich offers a FREE course through edX on Agile software development
- BEGINNERS (fun trailer for the course!)

LinkedIn Learning

- ONLINE: NOT FREE
- LinkedIn Learning offers over 100 courses in Agile software development. Courses are NOT FREE but prices for individual courses are not too steep.
    - 52 BEGINNER courses
    - 64 INTERMEDIATE courses
    - 1 ADVANCED course

MITRE (Acquisition in the Digital Age)

- ONLINE: FREE
- Agile Fundamentals Overview
    - This website includes an 8 minute FREE video that introduces the concept of Agile; there is even a glossary of Agile-related terms

O'Reilly Media - Technology and Business Training

- ONLINE: NOT FREE (DoD DOES partner with O'Reilly)
- O'Reilly Media is a learning company that publishes books, produces tech conferences, and provides an online learning platform. Programs for teams include business (Agile, product management, and team management)
    - NOT FREE: See pricing here (for individuals and teams); however, DoD DOES have a partnership with O'Reilly (civilians, military/families). You can register with the Military One Source Digital Library for access. You can also sign up for a FREE 10-day trial. There are a variety of books, playlists, videos on business (e.g., product and project management with resources on Agile and software estimation), data, design, and software development (e.g., architecture, coding, game development, programming, QA/testing) for ALL levels.

Software Engineering Institute (can customize training)

- **Agile Development: Myths, Monsters, and Fables (Brochure available)**
    - IN PERSON: 1 day (price unknown)
    - BEGINNER

  - Highlights insights gained by interacting with Agile programs in government settings. Some learning is in the form of myths about Agile that the Software Engineering Institute has encountered.

- **Agile In Government: Concepts for Senior Executives (Brochure available)**
  - IN PERSON: 2–4 hours (price unknown)
  - BEGINNER
  - This tutorial event is usually provided to a small group of senior executives in a program or enterprise who are contemplating or are already in progress with adoption of Agile approaches in their organization.

- **Agile's Roles/Responsibilities/Competencies (Brochure Available)**
  - IN PERSON: 2 hours (price unknown)
  - BEGINNER
  - This presentation provides an overview of the expanded role of the program office when employing Agile, including roles, responsibilities and competencies required of the program office and how the January 2015 DoD Instruction 5000.02 could support DoD programs with Agile contractors. In addition, a brief discussion of Agile in the Larger Eco-system will include a description of the forms of obstacles often posed by the surrounding systems engineering and acquisition ecosystem.

- **Agile in Government (AIG)—Practical Considerations (Brochure Available)**
  - IN PERSON; 1 day (price unknown)
  - BEGINNER
  - This live-delivery tutorial enables attendees to understand basic Agile concepts that developers use, primarily focusing on introducing the interactions that government program offices can and should have with developers (either organic or contracted) who are using Agile methods to develop government systems. A combination of lecture, discussion and short exercises are used to provide attendees with information that will translate into their work settings.

- **What Do I Do Monday? (Role-based Agile Workshops) (Brochure Available)**
  - 1–2 days depending on team's prior Agile knowledge (price unknown)
  - BEGINNER (for SPO staff)
  - The main goal of this workshop is to prepare acquisition staff with a starting set of knowledge and skills that will help them to recognize Agile approaches that developers are using and to help them to interact productively with contractors using Agile approaches.

- **Readiness/Fit Workshop (Agile Adoption Workshop) (Brochure Available)**
  - IN PERSON; 1.5–2 days (price unknown)
  - INTERMEDIATE
  - This workshop is directed at participants who have had some exposure to basic Agile concepts (Agile tenets and principles, common methods, terminology). The facilitator will help you explore your current program environment to determine

in what areas your team is more ready to adopt Agile methods, and identify adoption risks the team will face in areas where the team is not as ready. (Minimum of 6 participants; max of 20)

Udacity

- ONLINE: NOT FREE ($1017 for three months; or pay as you go for $399/month)
- BEGINNER
- Offers a NEW nanodegree program (short program, takes about 3 months to complete) in Agile software development

Udemy

- ONLINE: NOT FREE (individual prices are reasonable, e.g., some are $11.99).
- Udemy offers 117 courses on Agile software development.
    - 80 BEGINNER courses (example below):
        - Agile Software Transformation for Beginners 2020
            - ONLINE: 1 hour, 41 minutes ($24.99)
    - 34 INTERMEDIATE courses
    - 7 ADVANCED courses

U.S. Government Accountability Office

- Provides FREE short videos on YouTube that complement their "Agile Software Development" short paper and their recently released "Agile Assessment Guide: Best Practices for Agile Adoption and Implementation" (September 28, 2020)

B. ARTIFICIAL INTELLIGENCE (AI) / MACHINE LEARNING (ML)

ARTIFICIAL INTELLIGENCE (AI)

Army (in partnership with Carnegie Mellon University)

- A master's program has been recently approved to bring in young officers, non-commission officers, and warrant officers to learn about artificial intelligence
- IN PERSON: 4-5 months, followed by 5-6 months with the Army AI Task Force
- BEGINNER (initially)

Carnegie Mellon University, School of Computer Science (Brochure Available)

- Artificial Intelligence Short Course
    - MODE UNKNOWN (price unknown)
    - BEGINNER
    - Introduces audiences of all backgrounds to the theory and development of computer systems, key technology blocks that enable artificial intelligence (the "AI Stack"), how artificial intelligence impacts industry, and the engineering challenges in the field.

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Coursera

- ONLINE: NOT FREE (DAU possesses a license for Coursera)
- Coursera offers over 800 beginner, intermediate, and advanced classes in AI
    - 274 BEGINNER courses
    - 404 INTERMIEDIATE courses
    - 62 ADVANCED courses
    - 89 MIXED courses

Defense Acquisition University

- ISA 1011 - Basic Information Systems Acquisition
    - ONLINE: Approximately 12 hours
    - BEGINNER
    - Added modules that focus on software topics (revised in October 2020)
    - Module 11: AI: (Acquiring AI and Machine Learning)

Department of Energy

- The Department's Artificial Intelligence and Technology Office, in coordination with the DoE's 17 national laboratories, is planning to "upskill" technically savvy employees with an interest in artificial intelligence (timeline is fall 2020)

Harvard (offers mostly FREE online courses, including 50 in computer science)

- CS50's Introduction to Artificial Intelligence with Python
- ONLINE: 7 weeks (your pace) (FREE to audit; add a verified certificate for $199)
- BEGINNER

IBM

- "IBM Skills" helps students, professionals, job seekers and small businesses build critical skills through FREE online courses, programs, and badge credentials created in partnership with governments, NGOs and schools from all over the world. Topics include artificial intelligence and Watson.
- ONLINE: FREE
- BEGINNER

LinkedIn AI Academy

- LinkedIn AI Academy offers 204 AI courses of varying length and topic (e.g., cybersecurity, fintech, project management). These courses are NOT FREE, but individual courses are usually pretty reasonable.
    - 140 BEGINNER courses
    - 137 INTERMEDIATE courses
    - 3 ADVANCED courses (example below)
        - AI for Gaming
            - ONLINE: 2 hours, 5 minutes ($39.99)
- Career pathways in AI and ML are available here

Massachusetts Institute of Technology

- Artificial Intelligence: Implications for Business Strategy (see trailer here)

  - ONLINE: 6 weeks ($3200)
  - TECH BEGINNER; FOR MANAGERS AND HIGH-LEVEL EXECUTIVES
  - Can earn an MIT Sloan School certificate
- Artificial Intelligence (taught in 2010, an older course so proceed with caution)
  - ONLINE: Length of class unknown (FREE)
  - BEGINNGERS (for undergraduate students)

Pluralsight

- Pluralsight offers 283 AI courses. SOME are FREE (some are also linked to machine learning). The big picture (FREE) and executive briefing (40 minutes, NOT FREE) courses look ideal for beginners and leadership.
  - 91 BEGINNER courses
  - 125 INTERMEDIATE courses (example below)
    - Your AI Is Wrong! Lessons from Decision Making with Imperfect AI
      - ONLINE: 23 minutes (NOT FREE)
  - 67 ADVANCED courses (example below)
    - Using Pre-Built AI to Solve Business Problems
      - ONLINE: 46 minutes (NOT FREE)

Stanford

- Artificial Intelligence: Principles and Techniques
  - IN PERSON (PREVIOULSY): FREE
  - BEGINNER (there ARE prerequisites)
  - There is a FREE hour-long video on the course website that provides an introduction on artificial intelligence (introduces concepts)
  - The course does fill up (at least the in-person course)

UC Berkeley

- Artificial Intelligence Strategy (short course)
  - ONLINE: 6 weeks (price unknown, but you can request a brochure)
  - BEGINNER; for NON-TECHNICAL leaders of technology teams

Udacity: School of Artificial Intelligence

- Udacity's School of Artificial Intelligence offers a variety of courses on AI such as AI in health care, AI in trading, natural language processing, etc.
- SOME of the courses are FREE. For the most part, you can pay for access for four months [usually over $1000], or per course [usually over $300]. Prices vary). Some examples are below.
  - Artificial Intelligence
    - ONLINE: 3 months
    - INTERMEDIATE
  - AI for Business Leaders
    - ONLINE: 4-8 weeks
    - INTERMEDIATE
  - Artificial Intelligence (offered by Georgia Tech through Udacity)

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

        - ONLINE: 4 months (FREE)
        - INTERMEDIATE
    - Introduction to Artificial Intelligence
        - ONLINE: 4 months (FREE)
        - INTERMEDIATE
- FREE course are available here (bottom of page)
- Career pathways in AI and ML are available here (middle of page)

Udemy

- ONLINE: NOT FREE
- Udemy offers 259 AI courses
    - 120 BEGINNER courses
    - 32 INTERMEDIATE courses
    - 6 EXPERT courses
    - 101 ALL LEVELS
- NOTE: Data engineer courses seem to be included in the above courses

MACHINE LEARNING (ML)

Amazon

- Machine Learning University offers 67+ machine learning courses.
- Developers, data scientists, data platform engineers, and business decision makers can use this training to learn how to apply ML, AI, and deep learning to their businesses unlocking new insights and value.
    - For each subject matter (see their respective page), there is a career path

LinkedIn Learning

- ONLINE: NOT FREE
- LinkedIn Learning offers over 600 courses in machine learning
- 231 BEGINNER courses
- 475 INTERMEDIATE courses
- 28 ADVANCED courses

Pluralsight

- ONLINE: NOT FREE
- Pluralsight offers over 900 courses in machine learning
    - 341 BEGINNER courses (example below)
        - Understanding Machine Learning
            - ONLINE: 43 minutes
    - 441 INTERMEDIATE courses (example below)
        - Machine Learning Business for Professionals
            - ONLINE: 5 hours, 23 minutes
    - 204 ADVANCED courses

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Udemy

- ONLINE: NOT FREE
- Udemy offers over 200 courses in machine learning
    - 170 BEGINNER courses
    - 96 INTERMEDIATE courses
    - 14 EXPERT courses

Udacity

- Udacity also provides a career path for ML engineer (good sample to review)

C. CYBER (BOUND BY SOFTWARE)

Air Force Institute of Technology

- Cyber 200/220/ and 300 courses: https://www.afit.edu/EX/cyber.cfm
- SYS 240, SYS 341, and CYB 150 courses: https://www.afit.edu/LS/catalog.cfm?t=2

Defense Acquisition University

- ACQ 160 Program Protection Planning Awareness
- ENG 260 Program Protection for Practitioners
- Program Protection Credential consists of ACQ 160 and ENG 260, along with a comprehensive exam.
- Cybersecurity for Program Managers Credential to be deployed in October 2020
- CLE074 Cybersecurity Throughout DoD Acquisition
    - ONLINE: 3 hours
    - BEGINNER-INTERMEDIATE
- WSA 002 DevSecOps for Cyber Professionals (DCP) [workshop]
- WSS 001 Cybersecurity and Acquisition Integration [workshop]
- WSS 002 Advanced Cybersecurity Risk Management Workshop
- WSS 003 Information System Security Manager (ISSM)
- WSS 005 Program Protection [workshop]
- WSS 006 Cybersecurity Experiment (CYBEX) [workshop]
- WSS 007 Cyber Table Top [workshop]
- WSS 008 Controlled Defense Information [workshop]
- WSS 010 Cyber Training Range [workshop]

George Washington

- ONLINE: NOT FREE (part-time program costs $10,000; full-time program costs $11,995. Scholarships and payment plans are available to those who qualify)
- George Washington University offers a boot camp on cybersecurity. This program is offered through the George Washington College of Professional Studies, in partnership with Trilogy Education Services, a 2U, Inc. brand.

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

IBM

- "IBM Skills" helps students, professionals, job seekers and small businesses build critical skills through FREE online courses, programs, and badge credentials created in partnership with governments, NGOs and schools from all over the world. There are multiple resources and FREE online courses provided in cybersecurity. For example:
    - IT Fundamentals for Cybersecurity Specialization (offered through Coursera; DAU possesses a license)
        - ONLINE: 4 months (enroll for FREE)
        - BEGINNER

Linux

- ONLINE: NOT FREE
- Apache Web Server Hardening
    - ONLINE: 19 hours (NOT FREE)
    - INTERMEDIATE

National Centers of Academic Excellence in Cyber Defense

Software Engineering Institute

- Offers a variety of online courses in topics like network and security
    - Cybersecurity Engineering and Software Assurance Professional Certificate
        - ONLINE (can also be instructor-led): $1250.00
        - INTERMEDIATE-ADVANCED (for software developers and engineers)
    - Cybersecurity Oversight for the Business Executive
        - ONLINE: 2 days ($2000 for government employees)
        - BEGINNINER (for leadership)

Stanford

- Introduction to Web Security
    - ONLINE: Short course (does not specify length) (FREE)
    - BEGINNER

Udemy

- ONLINE: NOT FREE
- Udemy offers over 300 cybersecurity courses related to IT and software
    - 120 BEGINNER
    - 38 INTERMEDIATE
    - 10 EXPERT COURSES
- Udemy offers 252 network and security courses related to IT/software
    - 92 BEGINNER courses
    - 33 INTERMEDIATE courses
    - 6 EXPERT courses

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

D. DATA (BOUND BY SOFTWARE)

Air Force Institute of Technology

- Introduction to Data Analytics (DAS 101) - online
- Fundamentals of Data Analytics (DAS 201)
- Enhancing a Data Analytics Culture (DAS 460) – COMING SOON
- Fundamentals of Data Management (SYS 110) – online
- As well as several Workshops on topics such as Data Analytics Tools and Techniques, Data Architecture, R, and Python (https://www.afit.edu/LS/catalog.cfm?t=3)

Coursera

- ONLINE: NOT FREE (DAU possesses a license for Coursera)
- Offers over 1900 beginner, intermediate, and advanced classes in data science
    - 695 BEGINNER courses
    - 813 INTERMEDITATE courses
    - 113 ADVANCED courses
    - 322 MIXED LEVEL courses

Defense Acquisition University

- Data Science/Artificial Intelligence Executive Overview
    - Lesson available in executive program manager courses and Defense Acquisition Executive Overview Workshop
- Data Analytics for DoD Acquisition Managers Workshop
- Data Science/Artificial Intelligence Course in Cooperation with George Mason
    - **Coming Soon in 2021!**

Galvanize Boot Camp

- ONLINE/IN PERSON (ALL ONLINE NOW)
- Data Science Immersive Bootcamp
- 13 weeks ($17,000!!!)

General Assembly Boot Camp

- ONLINE: NOT FREE
- Data Science Immersive Online (Full-time)
    - ONLINE (also offered on campus) (see web page for prices)
- Online Data Science Course
    - Part-Time (see the web page for prices)

Harvard (part of Harvard's Professional Certificate Program in Data Science; ALL FREE. Courses increase in level of difficulty throughout the program)

- Data Science: Probability (8 weeks)
- Data Science: R Basics (8 weeks)
- Data Science: Inference and Modeling (8 weeks)
- Data Science: Productivity Tools (8 weeks)
- Data Science: Wrangling (8 weeks)

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- Data Science: Linear Regression (8 weeks)
- Data Science: Machine Learning (8 weeks)
- Data Science: Visualization (8 weeks)
- Data Science: Capstone (2 weeks)

IBM

- "IBM Skills" helps students, professionals, job seekers and small businesses build critical skills through FREE online courses, programs, and badge credentials created in partnership with governments, NGOs and schools from all over the world. There are multiple resources and FREE online courses provided in Analytics.
- IBM also offers a data science certificate through Coursera
    - ONLINE: 10 months (NOT FREE; DAU possesses a license for Coursera)

Lambda School

- Offers curriculum in data science (applied statistics and machine learning); however, curriculum can be customized. They are also able and willing to partner with organizations, including the federal government.
    - ONLINE: NOT FREE ($30,000, however, they offer an income share agreement)
    - Offer full time (6 months to complete) and part time (12 months to complete)
    - Classes are remote but interactive and have a rigorous structure so you'll graduate with all the skills you need to make an impact on day one. Plus, you'll build a real product with a team of 6-8 students from other tracks.
    - NOTE: Members from the software workforce working group have spoken with them before; they are very willing to work with the DoD/customize training.

LinkedIn Learning

- ONLINE: NOT FREE
- There are at least 1,000 courses in data science
    - 719 BEGINNER courses (examples below)
        - Introduction to Data Science
            - ONLINE: 1 hour, 48 minutes (NOT FREE)
            - BEGINNER
        - Data Science Foundation: Fundamentals
            - ONLINE: 3 hours, 41 minutes ($39.99)
            - NON-TECHNICAL COURSE (BEGINNER-INTERMEDIATE)
    - 1310 INTERMEDIATE courses
    - 85 ADVANCED courses

Pluralsight

- ONLINE: NOT FREE
- Pluralsight offers over 200 courses in data science
    - 97 BEGINNER courses (example below)
        - Data Science for Executives
            - ONLINE: 27 minutes (NOT FREE)
    - 98 INTERMEDIATE courses

- 67 ADVANCED courses

Udacity (School of Data Science)

- ONLINE: FREE courses are offered here (bottom of page)

Udemy

- ONLINE: NOT FREE
- Udemy offers 165 courses in data science
  - 134 BEGINNERS courses. For example
    - Introduction to Data Science: Your Step-By-Step Guide to Starting
      - ONLINE: 5.5 hours ($94.99) (BEGINNER FAVORITE!)
  - 49 INTERMEDIATE courses
  - 4 EXPERT courses
- NOTE: A data engineer career pathway is available here.

E. DESIGN

Coursera

- ONLINE: NOT FREE (DAU possesses a license)
- Coursera offers over 400 courses in design thinking
  - 210 BEGINNER courses (examples below)
    - UX/UI Design Specialization
      - ONLINE: 4 months (Enroll for free)
      - BEGINNER (increases in difficulty as you take the courses)
    - User Experience Research and Design Specialization
      - ONLINE: 9 months (Enroll for free)
      - BEGINNER
    - Introduction to User Design Experience
      - ONLINE: 7 hours (Enroll for free)
      - BEGINNER
    - Agile Meets Design Thinking
      - ONLINE: 9 hours (Enroll for free)
      - BEGINNER
  - 87 INTERMEDIATE courses
  - 22 ADVANCED courses
  - 94 MIXED LEVEL courses

edX

- ONLINE: edX seems to have more FREE courses than other commercial sources. They offer a variety of design thinking courses through universities.
  - Designing the User Experience
    - ONLINE: 4 weeks (FREE)

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

General Assembly

- ONLINE: NOT FREE (Full tuition is $3950)
- UX Design Course

George Washington University

- ONLINE: NOT FREE (part-time program costs $10,000, full-time program costs $11,995. Scholarships and payment plans are available to those who qualify)
- George Washington offers a UX/UI boot camp. This program is offered through the George Washington University College of Professional Studies, in partnership with Trilogy Education Services, a 2U, Inc. brand.

Google

- **UX Designer Certificate → Coming Soon!**
- Like Google's existing IT Support Specialist Certificate offered through Coursera, this will probably take 3-6 months but students go from BEGINNER to job ready
- NOT FREE, but according to an article, the IT program is about $49/month

IBM

- "IBM Skills" helps students, professionals, job seekers and small businesses build critical skills through FREE online courses, programs, and badge credentials created in partnership with governments, NGOs and schools from all over the world. Provides resources and online training in Enterprise Design Thinking. Badges are available.

LinkedIn Learning

- ONLINE: NOT FREE
- Offers courses on UX design (NOT FREE, reasonable per course)
    - 114 BEGINNER courses
    - 254 INTERMEDIATE courses
    - 12 ADVANCED courses
- Offers courses on design thinking (NOT FREE but reasonable per course)
    - 135 BEGINNER courses (examples below)
        - Learning Design Thinking: Lear Change in Your Organization
            - ONLINE ($29.99)
            - BEGINNER
        - Design Thinking: Understanding the Process
            - ONLINE: 41 minutes ($29.99)
            - BEGINNER
    - 89 INTERMEDIATE courses
- Offers courses on UI, mostly mixed in with UX and design thinking
- **NOTE:** LinkedIn Learning provides a career pathway for user experience design

openSAP

- Software Design for Non-Designers
    - ONLINE: 6 weeks (self-paced; about 3-4 hours/week) (FREE)
    - BEGINNER (for anyone interested in software design; no prerequisites)

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- Developing Software Using Design Thinking
  - ONLINE: 7 weeks (about 5 hours/week; self-paced) (FREE)
  - BEGINNER (anyone interested in design thinking; software professionals)
- Design-Led Approach for the Intelligent Enterprise
  - ONLINE: 5 weeks (about 2-4 hours/week; self-paced (FREE)
  - BEGINNER-INTERMEDIATE (product/project managers; designers; developers)

Open University (NOT FAMILIAR WITH THIS SITE; CAUTION)

- Design Thinking
  - ONLINE: 10 hours (FREE)
  - BEGINNER

Udacity

- ONLINE: FREE AND NOT FREE COURSES AVAILABLE
- Become a UX Designer
  - ONLINE: 3 months (NOT FREE)
  - BEGINNER
- Product Design
  - ONLINE: 2 months (FREE)
  - INTERMEDIATE
- Offers online nanodegree program (3 months) in UX Design (NOT FREE; $1017)
- FREE courses are available here (bottom of page)

Udemy

- ONLINE: NOT FREE
- Udemy offers courses on design thinking (NOT FREE)
  - User Experience Design
    - 77 BEGINNER courses
    - 19 INTERMEDIATE courses
    - 1 EXPERT course
    - 108 ALL LEVELS

F. PRODUCT

Coursera

- ONLINE: NOT FREE (DAU possesses a license)
- Coursera offers over 1000 courses in product management
  - 552 BEGINNER courses.
  - 256 INTERMEDIATE courses
  - 30 ADVANCED courses
  - 287 MIXED LEVEL courses

edX

- ONLINE: Offers many FREE courses

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

  - Product Management with Lean, Agile and System Design Thinking (offered through Boston University)
    - ONLINE (not currently available): 6 weeks (FREE)
    - ADVANCED
  - Modern Product Leadership (offered through University of Maryland)
    - ONLINE: 4 weeks (FREE)
    - BEGINNER

General Assembly

- ONLINE: NOT FREE
- General Assembly offers part-time online courses in product management

LinkedIn Learning

- ONLINE: NOT FREE
- Offers over 200 courses in product management
  - 173 BEGINNER courses
  - 73 INTERMEDIATE courses
  - 7 ADVANCED courses

SCRUM Alliance

- ONLINE: NOT FREE
- Two-day course to prepare employees to take on the Product Owner role and what it means to function as the Product Owner, or Customer, for a Scrum team. Become a Certified SCRUM Product Owner.
  - ONLINE: Over $900
  - INTERMEDIATE (need to have been a product owner for 1 year)

Stanford

- What Is Product Management?
  - ONLINE: 30 minutes (FREE)
  - BEGINNER
  - Provides an introduction to the NOT FREE ($675) course, *Product Management: Transforming Opportunities into Great Products*

Udacity

- ONLINE: NOT FREE
- Offers a nanodegree (relatively short) program in product management
- ONLINE: 4 months ($1356)
- BEGINNER

Udemy

- ONLINE: NOT FREE
- Udacity offers over 100 courses on product management (NOT FREE)
  - 45 BEGINNER courses (example below):
    - Become a Product Manager
    - ONLINE: 4 months ($399 per month, pay as you go)

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- 11 INTERMEDIATE courses
- 1 ADVANCED courses
- 44 ALL LEVEL courses

G. SOFTWARE ACQUISITIONS

GENERAL

Defense Acquisition University

- ISA 1011 - Basic Information Systems Acquisition
  - ONLINE IT/Software BASICS for approximately 12 Hours
  - BEGINNER
  - Modules in Iteration 1 in March 2020 include:
    - Module 0: Introduction (Seven DoD Software Domains; DoD Digital Modernization Strategy)
    - Module 1: IT/SW Importance to DoD: NDS – Deliver at Speed of Relevance
    - Module 2: IT Acquisition Pathway: (What is the Technology? Why is it important to DoD? How do we acquire it? Use of the Software Pathway; Infrastructure Acquisition)
    - Module 3: Architecture/Systems Engineering (Includes Enterprise Architecture to Software Architecture)
    - Module 4: Software Development: (Transformation from waterfall to Agile Software Development)
    - Module 5: Software Quality Management (Ensuring Quality is Baked in)
    - Module 6: Cybersecurity (Ensuring Cybersecurity is Baked in)
    - Module 7: Cloud Computing (Utilizing the Benefits of Cloud)
    - Module 8: DESMF/IT Service Management (Creating Proper Service Level Agreements)
    - Module 9: SW Support (Ensuring Design for Support is Baked in)
    - Module 10: Module 10 – Course Summary
  - Modules in Iteration 2 (June 2020) will add:
    - Module 10: DevSecOps (Development to Operations w/Security Baked in)
    - Module 11: AI: (Acquiring AI and Machine Learning)
    - Module 12: Data Management (National Interface Exchange Model (NIEM))
    - Module 13: Course Summary
- ISA 320 - Advanced Enterprise Information Systems Acquisition
  - IN-PERSON: 4.5 days, case based course focused on DoD Program-Level IT/Software, includes discussion on software intensive programs (e.g., F-18/F-35 programs)
- CLE041 Software Reuse
- CLE060 Practical Software and Systems Management
- CLE062 Capability Maturity Model-Integrated
- CLE068 Intellectual Property and Data Rights

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- CLE076 Introduction to Agile Software Acquisition
- CLE077 Defense Business Systems Acquisition
- CLE078 Software Acquisition for the Program Office Workforce
- CLE080 Supply Chain Risk Management for Information/Communications Technology
- CLE 081 Software Assurance Awareness
- CLE 083 Information Technology Service Management
- CLL027 Introduction to DoD Software Lifecycle Management
- ISA220 Risk Management Framework for the Practitioner
- WSA 005 Lean-Agile Transformation Workshop

Department of Defense Software Acquisition Pathway Training

- DoD 5000.87, "Operation of the Software Acquisition Pathway" published on 2 October 2020. Available here.
- Adaptive Acquisition Framework (web page on DAU's website)
- Adaptive Acquisition Framework/Software Pathway Roundtable (bottom of page)
- Overview of the Adaptive Acquisition Framework with Stacy Cummings
- Software Pathway Testimonial (Kessel Run, bottom of page)

Defense Innovation Board

- Changing Software Acquisition in DoD Roundtable w/Defense Innovation Board

Department of Homeland Security (for our information)

- Homeland Security Acquisition Institute (HSAI) Program/Acquisition Management Courses Action Courses with DHS Agile Policies and Practices
    - AQN 101 DHS Introduction to Acquisition
    - AQN 201 DHS Intermediate Systems Acquisition, PT A
    - AQN 201B DHS Intermediate Systems Acquisition, PT B

National Defense University

- Elective Course 6104, Senior Acquisition Course: Strategic Acquisition, Sustaining Technological Advantage in Defense Acquisition
    - ADVANCED: FOR SENIOR ACQUISTION LEADERS
    - Technological innovation continues to transform our world at an increasing pace (robotics, information and communications technology, genetics, nanotechnology, biotechnology, and more). Innovations can rapidly and unpredictably alter the balance of power in the world, while creating an opportunity for U.S. strategic advantage, if properly managed. Conversely, the decision support systems within the Department of Defense progress at the same methodical pace. This creates a tension between the dynamic world of innovation and a defense acquisition process characterized by highly defined methods, budgets, schedules, and oversight requirements. To alter this dynamic, U.S. Government acquisition leaders must be prepared to make strategic-level investment decisions at the nexus of technological innovation and the acquisition process to advance warfighting capabilities. Acquisition leaders must understand how to sustain the bedrock of U.S. national security strategy, technological innovation, while effectively managing defense acquisition processes. Thus, this elective analyzes strategic

acquisition approaches for sustaining U.S. technological advantage. *A technical background for this elective is not required.*
- Acquisition leaders (e.g., civilian [primarily GS-14s and GS-15s] and military personnel [primarily E5 and E6]); a majority of the students are part of the acquisition corps and/or are program managers.

Software Engineering Institute
- Acquisition curriculum is freely available here.
- Also offers online courses on acquisition
  - Acquisition Essentials for Software-Reliant Systems
    - ONLINE: 1 hour ($75)
    - BEGINNER-INTERMEDIATE: For acquisition program leaders and staff who are experienced with acquisition, but want more information about addressing the software aspects of the program.

CONTRACTING/PROCUREMENT

Air Force
- Contracting for Agile Software Development (presentation by Maj Gen Zabel)

Defense Acquisition University
- CME 250, Software Acquisition Management, Policy and Procedures
  - ONLINE: BEGINNER-INTERMEDIATE
- CME 260, Software Acquisition Management, Policy Implementation
  - ONLINE:
- CLC 011 Contracting for the Rest of Us

Department of Defense, Office of the Under Secretary for Acquisition & Sustainment
- *Contracting Considerations for Agile Solutions Key Agile Concepts and Sample Work Statement Language* (November 2019) (FREE RESOURCE)

Department of Defense, Enterprise Software Initiative (ESI)
- ESI's website provides information, resources, and training videos on negotiating terms and conditions for software license and maintenance agreements

Federal Acquisition Institute
- Applications in Contracting (not sure how much IT/SW acquisition is covered)
  - Intended for program and project management professionals seeking their FAC-P/PM Mid-level certification. Look for this class on the FAI schedule here (price unknown)
- New Courses
  - Contract Fundamentals (may not focus on IT/software acquisition)
  - Fundamentals of Cost and Price Analysis (may not focus on IT/SW acquisition)
  - Architect and Engineering Contracting
  - Contracting for Decision Makers

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- Acquisition Law (someone in the AWF said they are getting legal questions about purchasing software)

General Services Administration (18F) (FREE RESOURCES)

- *Agile Budgeting & Oversight Guide for State Governments* (2019)
- *De-Risking Government Technology: Federal Agency Field Guide* (Sept 2020)

TechFAR Hub

- Training Courses
  - Agile Acquisition 101 (FREE)
  - AGL Academy offers courses (price unknown) in:
    - Product Owner
    - Project Manager
    - Government Executive
  - Digital IT Acquisition Professional Training
    - Developed through a partnership between U.S. Digital Service and the Office of Federal Procurement Policy (OFPP) to develop a DITAP community of practice. The program is currently on its second pilot to develop a training and certification program for contracting officers. See latest content here (price unknown).
  - ASPE Agile Training Courses on Agile project delivery (NOT FREE)
- Behind the Buy Podcasts (FREE)

LEGAL

Open University (NOT FAMILIAR WITH THIS SITE AT ALL; CAUTION)

- Open University offers multiple FREE courses
  - Software and the Law
    - ONLINE: 8 hours (FREE)
    - ADVANCED

PROGRAM/PROJECT MANAGEMENT

Air Force Institute Technology

- SWE 301, Software Project Management (coming soon!)
  - This course provides a comprehensive review of the phases, processes and models used by the Air Force in the management of a software project. Topics include performing software source selection, understanding and generating various project management metrics, creating an environment for success, dealing with failure and misconceptions, and how to interact with stakeholders.
- FAM 104, Air Force Fundamentals of Acquisition Management
  - The first week of FAM 104 focuses on basic project management skills based on the Project Management Body of Knowledge from the Project Management Institute. The remainder of the course provides students an overview of the entire weapon system acquisition process using key DoD and Air Force level documents

as well as Air Force specific processes and methodologies. The course also covers information on the various functional disciplines required to execute an acquisition program. Includes instruction on other topics such as teaming, communication, ethics, and the Acquisition Professional Development Program. There is a brief lesson in FAM 104 (a 3-week initial skills training course offered at WPAFB) that introduces Agile software development as one of the methodologies for acquiring software.

- IPM 301, Intermediate Project Management Skills Course
  - Provides Air Force officers and civilians a deeper foundation in everyday project management skills. More advanced project management topics are addressed using a combination of in-class lectures and discussions, project management readings and case studies, and individual/group exercises. Topics include: business case analysis, stakeholder management, communications management, time management, project planning, project execution and status reporting, project recovery, and transferring project management responsibility. The centerpiece of the course is a dynamic project management simulation, which integrates and applies these project management topics.
- LOG 238, Critical Chain Project Management Foundational Concepts
  - The Critical Chain Project Management (CCPM) Foundational Concepts course provides students with an introduction to critical chain project scheduling procedures, management tools and processes, and organizational requirements. Topics are presented in sufficient depth to allow students to successfully participate in the transition to and sustainment of CCPM as a primary workload planning, scheduling, and execution tool for Programmed Depot Maintenance and other project management activities. The course is designed for mid and upper level managers responsible for coordinating and directing the organizational resources, policies, and metrics necessary to implement and sustain CCPM. This course educates managers on the general theory of CCPM rather than providing training on any particular CCPM based scheduling software. In three class days, the course presents a detailed CCPM model and relates it to the Theory of Constraints, classical project scheduling, and continuous process improvement. Concepts are introduced through lecture, videos, and illustrated/reinforced through a number of simulations, exercises, and daily homework.
  - Feedback: “I have been involved with software since the early 1980s and USAF civilian employee for the past 27 years including software development, software testing, project management, and supervision. The best software training I ever took was Critical Chain Project Management from the Air Force Institute of Technology (AFIT). Nothing ever gave me more timely insight into the state of my software project and provided more positive impact to cost, schedule, and quality than Critical Chain.”

Construx

- IN PERSON AND ONLINE: FREE AND NOT FREE
- Construx offers both free and not-free training and consulting resources

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- Free software estimation webinars, including the "10 Deadly Sins of Software Estimation," and other resources are available here; other training resources, including for Agile, are available (virtual/in person and self-paced) here

Coursera

- ONLINE: NOT FREE (DAU possesses a license)
- Coursera offers a variety of courses on software project management
    - 293 BEGINNER courses
    - 195 INTERMEDIATE courses
    - 24 ADVANCED courses

Department of Homeland Security (for our information)

- The Homeland Security Acquisition Institute (HSAI) Program/Acquisition Management Courses provide Courses with DHS Agile Policies and Practices
    - APM 201: DHS Program Management Fundamentals
    - APM 250: DHS Program Management Tools
    - APM 350 DHS Senior Acquisition Program Management

Defense Acquisition University

- CLB 023: Software Cost Estimating
- PMT 2520 Program Management Tools Course, Part I
- PMT 257 Program Management Tools Course, Part II
- PMT 355 Program Management Office Course, Part A
- PMT 3550 Program Management Office Course, Part A
- PMT 360 Program Management Office Course, Part B
- PMT 401 Program Manager's Course
- PMT 402 Executive Program Manager's Course

edX

- ONLINE: offers mostly FREE courses on project management, including Agile
    - Applied Scrum for Agile Project Management (University of Maryland)
        - ONLINE: 4 weeks (FREE)
        - Can also enroll in University of Maryland's professional certificate program in Agile software development; NOT FREE ($895)

LinkedIn Learning

- ONLINE: NOT FREE
- LinkedIn Learning offers over 300 courses on Agile project management.
    - 205 BEGINNER courses
    - 177 INTERMEDIATE courses
    - 45 ADVANCED courses

Naval Postgraduate School

- MN3309 Software Acquisition Management for Strategic/Tactical Systems in Cyber Age
    - INTERMEDIATE

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

This course concentrates on the management of Software Products and Software Intensive Systems. It is intended to focus essential program management techniques on the software element to ensure successful and timely system development. The course provides the student with knowledge of software acquisition management control processes and tools. Current software acquisition articles and cases are analyzed for application of program leadership, software development techniques, and management tools applied. Topic areas include: DoD software environment; software acquisition strategies; impediments to successful Agile software intensive system development; software-oriented requirements development; contracting for software, software discriminate proposals; software test and evaluation management; Post Deployment Software Support; risk management; cyber security management (Risk Management Framework), and software costing and budgeting. Integrative exercises involving software managerial problem-solving and decision-making in the program management environment are used. **Prerequisites:** MN 3331, Principles of Acquisition and Program Management or MN3301 Acquisition Management Principles, or both MN3221 Introduction to acquisition Management (part 1)/MN3222 (part 2)

QAI-eLearning (an IEEE partner but I am not familiar with this site; CAUTION)

- ES 100: Software Estimation (there are other similar courses listed on the page)
  - ONLINE: 24 hours ($192)
  - BEGINNER

QAI-eLearning (an IEEE partner but I am not familiar with this site, so CAUTION)

- SE201: Basic Concepts of Software Project Management
  - ONLINE: 8.5 hours ($68)
  - BEGINNER-INTERMEDIATE

Udemy

- ONLINE: NOT FREE
- Offers courses on program/project management for software
  - Project Management: Simple Software Project Management
    - ONLINE: 1.5 hours ($12.99 for now)
    - BEGINNER-INTERMEDIATE (need to know some software ENG)
  - Waterfall to Agile Project Management
    - ONLINE: 2 hours ($12.99 for now!)
    - BEGINNER
  - Fundamentals of Agile Project Management
    - ONLINE: 2 hours ($12.00 for now)
    - BEGINNER

H. TECHNICAL

CLOUD

Amazon

- See the career pathway for an Amazon cloud practitioner

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Amazon-DoD Cloud Developer Recommended Courses (in a PDF document)

Coursera

- Offers over 400 courses on cloud computing through various universities. These courses are NOT FREE, but DAU possesses a license for Coursera; sometimes you can also enroll in a course for free.
    - 159 BEGINNINER courses
    - 233 INTERMEDIATE courses
    - 35 ADVANCED courses
    - 26 MIXED courses

Defense Acquisition University

- CLE075 Introduction to Cloud Computing
    - ONLINE: 4 hours
    - BEGINNER
- WSA 004 Cloud Services Workshop

Google Cloud Training

- Google offers a variety of online and in-person/virtual cloud training (to include infrastructure modernization, networking and security, machine learning and artificial intelligence, and google cloud in business) and learning paths from beginners to experts in Google cloud. Can also earn a badge in Google cloud.

IBM

- "IBM Skills" helps students, professionals, job seekers and small businesses build critical skills through FREE online courses, programs, and badge credentials created in partnership with governments, NGOs and schools from all over the world. There are multiple resources and FREE online courses provided in cloud computing. For example:
    - Introduction to Cloud
        - ONLINE: 4-6 hours (FREE)
        - BEGINNER

LinkedIn Learning

- ONLINE: NOT FREE
- Offers 893 courses in cloud computing
    - 269 BEGINNER courses
    - 557 INTERMEDIATE courses
    - 67 ADVANCED courses

Linux

- ONLINE: NOT FREE
- Compliance in the Cloud Fundamentals
    - ONLINE: 2 hours (NOT FREE)
- Cloud Security Fundamentals
    - ONLINE: 2 hours (NOT FREE)

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Udacity

- Offers a program for AWS Cloud Architect
- Offers a program for Cloud Developer
- Offers a program for Cloud DevOps Engineer

Udemy

- ONLINE: NOT FREE
- Udemy offers over 800 courses in cloud computing
    - 269 BEGINNER courses
    - 557 INTERMEDIATE courses
    - 67 ADVANCED courses

DEVSECOPS

Air Force

- Chief Software Officer Website
    - Training Resources

Coursera

- ONLINE: NOT FREE (DAU possesses a license for Coursera)
- Coursera offers over 40 courses in DevOps
    - 8 BEGINNER courses (example below)
        - Continuous Delivery and DevOps
            - ONLINE: 8 hours (Enroll for FREE)
    - 28 INTERMEDIATE courses (example below)
        - DevOps Culture and Mindset
            - ONLINE: 14 hours (Enroll for FREE)
    - 2 ADVANCED courses

Defense Acquisition University

- DevSecOps Academy (resources available)
- WSA 001 DEVSECOPS for the DoD Workshop
- WSA 002 DevSecOps for Cyber Professionals (DCP) [workshop]
- ISA 1011 - Basic Information Systems Acquisition
    - ONLINE
    - BEGINNER
    - Module 10: DevSecOps (From Development to Operations with Security Baked in; revised in October 2020)

edX

- ONLINE: Offers many FREE courses through universities
- Introduction to DevOps and Site Reliability Engineering
    - Offered through the Linux Foundation
    - ONLINE: 10 weeks (FREE)

- BEGINNER

LinkedIn Learning

- Offers over 500 courses in DevOps (NOT FREE; can pay by class)
  - 183 BEGINNER courses
  - 288 INTERMEDIATE courses
  - 54 ADVANCED courses

Linux

- DevSecOps Essentials
  - ONLINE: 6 hours (NOT FREE)
  - BEGINNER

Linux Foundation

- Open source training. Classes are available as both instructor-led and online, self-paced training. NOT FREE. The price per course seems to be $299, on average.
  - Containers Fundamentals (LFS253)
  - Containers for Developers and Quality Assurance (LFD254)
  - Kubernetes Fundamentals (LFS258)
  - Kubernetes Administration (LFS458): 4-day instructor-led class
  - Kubernetes for Developers (LFD259)
  - Kubernetes for App Developers (LFD459): 3-day instructor-led class
  - Monitoring Systems and Services with Prometheus (LFS241)
  - Cloud Native Logging with Fluentd (LFS242)
  - DevOps and SRE Fundamentals: Implementing Continuous Delivery (LFS261)
  - DevOps for Network Engineers (LFS266)

Software Engineering Institute

- Provides a variety of online training for a reasonable price (some are pricey)
- Secure DevOps Process and Implementation
  - ONLINE: 4.5 hours ($100)
  - BEGINNER: For anyone working in software development, including technical managers, technical leads, developers, QA engineers, release/deployment engineers and operational support staff who want to bring DevOps to their organization; want to improve their existing DevOps strategy; are looking for solutions to manage evolving software development needs; are challenged by slow deployment cycles; see a disconnect between business needs, development and operational teams; and are looking for strategies to convince their business of the benefits of DevOps.

Udacity

- ONLINE: FREE AND NOT FREE COURSES
- Intro to DevOps: Improving Software Lifecycle
  - ONLINE 3 weeks (FREE)
  - ADVANCED

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Udemy

- ONLINE: NOT FREE
- Udemy offers multiple courses on DevOps
  - 44 BEGINNER courses
  - 36 INTERMEDIATE courses (example below)
    - How to Effectively Implements Security Management in DevOps
      - ONLINE: 1 hour ($19.99)
  - 3 EXPERT courses

SOFTWARE DEVELOPMENT/SOFTWARE ENGINEERING

Air Force Institute of Technology

- SWE 201, Introduction to Software Engineering
  - This course defines and describes the software engineering book of knowledge (SWEBOK) lifecycle phases, how software engineering activities are managed through the Guidelines for Successful Acquisition and Management of Software-Intensive Systems (GSAM), and principle areas of interest and concern when working on a software intensive program. Students learn fundamental software engineering concepts used in the DOD, identify common software management, acquisition and engineering roles, and understand the Air Force's principle software engineering concerns. SWE 201 is taught online by asynchronous distance learning.

Alison (not familiar with this site, use caution)

- Alison offers multiple courses on software development and software engineering as well as network and security, game development, software tools, IT management, mobile apps, and data science. MOSTLY FREE COURSES
  - DevOps: Application Lifecycle Management
    - ONLINE: 2-3 hours (FREE)
    - ADVANCED

Amazon

- See the career pathway for Amazon developers here

Army NEW

- Quantum Leap is a new program to recode, reskill, and upskill Army civilians in cloud engineering, data engineering, data architecture, and software development. See an article about Quantum Leap here and Quantum Leap's new website here.

Army Communications-Electronics Command, Software Engineering Center

- Software Engineering Center University focuses on providing training customized to SEC mission needs not only to fill current skills gaps, but to cross-train across programs to ensure the ability to shift resources where needed to accomplish future mission requirements; 35 classes provided to 427 employees in FY19.

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Army Futures Command

- The new software factory at Army Futures Command will offer a 6-12 week course to teach soldiers basic software skills.
    - The Army just partnered with Austin Community College (September 2020) to host the new Army software factory. The college will provide training to soldiers and students in software development, leadership, and problem solving. Curriculum will also be offered in data science and artificial intelligence.

BESPIN (U.S. Air Force Software Factory)

- Drudonna
    - Boot-camp style education (first step for Airmen as they take on new tech roles); BESPIN Drudonna team partners with vendor company Big Nerd Ranch to provide students with top-notch training and education.
    - Three-week iOS boot-camp covers full stack development, Swift programming, Agile methodologies, user stories, Git usage, design concepts, and culminates in a capstone project to demonstrate comprehension.
    - The ideal Drudonna student is an airman who does not have formal training but has been writing code on the side/would like more education.
    - The next course is from 2-20 November 2020; the course is normally taught in person; however, it is currently being taught online
- Digital University
    - An online learning platform; courses are offered from BESPIN vendor partners (Udacity, Udemy, and Pluralsight); interfaces with Digital Leap and Drudonna
    - Led by BESPIN developers with support from senior developers from BESPIN vendor partners (Fearless, OMNI, and Hypergiant)
    - Beta testers currently limited to Airmen but will branch out

Boot Camps

There is a list of the 48 best coding boot camps available here. These are NOT free, some are cheaper than others (e.g., Fullstack online courses are $100). General Assembly IS on here, but I didn't see Galvanize.

Coursera

- ONLINE: NOT FREE (DAU possesses a license)
- Offers over 1000 courses on software development on a variety of topics including design and architecture, digital product management, software development lifecycle, programming
    - 405 BEGINNER courses (example below)
        - University of Geneva offers an online course for beginners called Simulation and Modeling of Natural Processes. Syllabus is available here.
        - ONLINE: 23 hours (enroll for FREE)
    - 376 INTERMEDIATE courses (example below)
        - The University of Minnesota offers a course on Software Development Lifecycle Specialization
            - ONLINE: 4 months (enroll for FREE)
            - BEGINNER-INTERMEDIATE (no programming experience)

        - There are four courses in this specialization
        - Software Development Processes and Methodologies
        - Agile Software Development
        - Lean Software Development
        - Engineering Practices for Building Quality Software
    - 43 ADVANCED courses
    - 216 MIXED LEVEL courses

Dcode

- Dcode connects government and industry and offers training (NOT FREE) to government
    - Dcode Advance: foundational course on innovation for government
    - Dcode Procure: course for acquisition professionals
    - Dcode Sustain: follow-on course to Dcode Advance
    - Dcode Eureka: one-day training for government leaders on tech topics
- Dcode has partnered with the Army's training with industry program
- Each year, Dcode runs several accelerator cohorts that focus on an emerging tech area (2020 is about DevOps and Security). As part of the Dcode Accelerate program, Dcode hosts meetings to bring together government and industry and tech. 2020's FREE virtual meeting is being hosted from October 20-22

edX

- Offers a variety of software development courses (including topics in AWS, DevOps, artificial intelligence, machine learning, Kubernetes, and software engineering) through partnerships with colleges and universities.
- Some classes are FREE
    - There are three NEW, FREE courses (developed by a former employee at the Institute for Defense Analyses, currently working at the LinuxFoundationX) available. You can earn a Professional Certificate in Secure Software Development Fundamentals for a cost; however, the three individual certificate courses are FREE
        - Secure Software Development: Requirements, Design, and Reuse
            - ONLINE: 7 weeks (FREE)
            - BEGINNER
        - Secure Software Development: Implementation
            - ONLINE: 7 weeks (FREE)
            - BEGINNER
        - Secure Software Development: Verification and More Specialized Topics
            - ONLINE: 7 weeks (FREE)
            - BEGINNER

Galvanize

- Offers part-time and full-time bootcamps in software engineering (NOT FREE)
- Galvanize has ALSO just partnered with Platform One (an Air Force Software Factory); its commercial propriety LEARN training and technology system has been modified to deploy on the Platform One, Air Force, and DoD technology platform. A 3 day workshop is also available. See more information about the partnership here.

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

George Washington University

- ONLINE: NOT FREE (part-time program costs $10,000/full-time program costs $11,995. Scholarships and payment plans are available for those who qualify)
- George Washington offers part-time and full-time coding boot camps. This program is offered through the George Washington College of Professional Studies, in partnership with Trilogy Education Services, a 2U, Inc. brand.

Google

- Google's Grow with Google Training is FREE to help grow skills, career, or business. Offers courses for small business, military/veterans, and developers
    - Google Developers Training is a set of online coding courses created by Google engineers. Topics include: training for android/web developers, firebase, Machine Learning & TensorFlow. Other courses include product design, VR software development, rapid prototyping, and Scalable Microservices with Kubernetes.
    - Google and Udacity also teamed up to create free, online courses. To learn more, visit udacity.com/google.
- Google Tech Talks
    - There are multiple FREE videos on a variety of topics, including software development. However, some of the courses are very old so they could be out of date, technology wise.

Harvard

- Harvard offers FREE computer science courses
    - Mobile app development with react native (13 weeks)
    - Web programming with python and JavaScript (12 weeks)
    - Introduction to computer science (11 weeks)
    - Python for research (5 weeks)
    - Game development (12 weeks)

IBM

- "IBM Skills" helps students, professionals, job seekers and small businesses build critical skills through FREE online courses, programs, and badge credentials created in partnership with governments, NGOs and schools from all over the world (FREE)
    - Blockchain
    - Internet of Things (under SD)
    - Enterprise Computing (under SD)
    - Quantum (under SD)

Institute of Electrical and Electronics Engineers

- Software Maintenance Course (skill level unknown)
    - ONLINE: 8 hours (self-paced) ($85 for members; $110 for non-members)

Johns Hopkins University

- Coding Boot Camp
    - ONLINE: 24 weeks (NOT FREE)

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Lambda School

- Offers curriculum in full stack web; however, curriculum can be customized. They are also able and willing to partner with organizations.
    - ONLINE: NOT FREE ($30,000, offer an income share agreement)
    - Offer full time (6 months to complete)/part time (12 months to complete)
    - Classes are remote but interactive and have a rigorous structure so you'll graduate with all the skills you need to make an impact on day one. Plus, you'll build a real product with a team of 6-8 students from other tracks.
      NOTE: Members from the software workforce working group have spoken with them before; they are very willing to work with the DoD/customize training.

LinkedIn Learning

- ONLINE: NOT FREE
- 656 software development courses and 525 video tutorials for ALL levels.
    - Topics include: API, Database Development, Software Development Tools, Game Development, Internet of Things, Object-Oriented Programming, Programming Languages, Software Quality Assurance, Software Design, Version Control, Microsoft Development, Software Testing, Design Patterns, Enterprise Architecture, Programming Foundations, and Software Architecture.
    - There are 483 business software and tools courses and 931 video tutorials. There are also 721 data science courses and 283 video tutorials.

Linux Academy

- You can filter by platform (Cloud, AWS, Azure, Google Cloud, or Linux) or skill (security, DevOps, Big Data, or Containers). Hands-on labs are also available for most of these. Learning paths are also available for AWS, Azure, Cloud, Containers, DevOps, Google Cloud, Linux, OpenStack, and Security.
- There are SOME free offerings, but for resources you can pay $37.42/month billed as $429/year. See pricing.

Massachusetts Institute of Technology

- MIT offers a variety of FREE online courses through their Open Courseware. Topics include artificial intelligence, modeling and simulation, project management (teaches Agile software development and Agile project management in a course about creating video games) and software engineering. NOTE: some classes are older than others so BEWARE. Levels are from BEGINNER to ADVANCED.
- Introduction to Modeling and Simulation provides lectures notes, videos, and other sources for this course
    - ONLINE: FREE (sources can be accessed online)
    - BEGINNER-INTERMEDIATE

Microsoft University (advanced)

- Microsoft University offers a wide range of advanced technical workshops especially designed for IT professionals (such as administrators and developers) at customers with a Microsoft Premier support contract.
    - NOT FREE, need a Microsoft Premier support contract

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Pluralsight

- ONLINE: NOT FREE
- Software Development courses include topics on web development, mobile development, JavaScript, C#, Python, Node.JS, C++, Ruby on Rails, and React.

Stanford

- Computer Science 101
  - IN-PERSON OR ONLINE: Full semester course (FREE)
  - BEGINNER
  - Not always open for enrollment
- Game Theory
  - ONLINE: Full semester course (FREE)
  - BEGINNER (there is a FREE follow-on course called, Game Theory II)
  - NOTE: It looks like this is a Coursera course

Udacity (works with Google)

- ONLINE: FREE AND NOT FREE
- Programs include programming and development, cloud computing, data science, business, and autonomous systems (examples below)
  - Software Development: Better Requirements Gathering Skills
    - ONLINE: 1.5 hours ($94.99)
    - BEGINNIER
  - VR Software Development
    - ONLINE: 1 month (FREE)
    - BEGINNINER
      - Upon completing this course, you will have learned basic programming constructs such as methods, loops, and variables. You will also be able to use events and know how to apply them in a virtual reality environment.
  - Software Development Process
    - ONLINE: 3 months (FREE)
    - INTERMEDIATE
      - Covers requirements engineering, architecture and design, testing and maintenance, and software quality in general
- SOME software courses are FREE (bottom of page).
- Career pathways for developers is available here (middle of page)

Udemy

- ONLINE: NOT FREE
- Offers a variety of courses in IT, software development, software engineering
  - Software Development courses include topics on web development, mobile apps, programming languages, game development, and databases, software testing, software engineering, development tools, and e-commerce (example below)
    - Software Requirements Specification: Develop Fast and Clear
      - ONLINE: 1 hour ($39.99)

        - INTERMEDIATE-ADVANCED
    - Software Engineering
        - 325 BEGINNERS courses
        - 250 INTERMEDIATE courses
        - 25 EXPERT courses
    - IT and Software courses include topics IT certification, network security, hardware, and operating systems.
    - Design courses include topics on web design, graphic design, design tools, user experience, game design, design thinking, 3D animation, and fashion.

U.S. Naval Community College

- Part of the Navy's Education for Seapower, the Naval Community College is the first priority in establishing the Naval University System. Accredited associate's degrees for enlisted in academic fields that directly impact the National Defense Strategy. The Navy is currently partnering with academic institutions**.**
    - Operational by January 1, 2021. See article.

U.S. Space Force

- **Supra Coders**
    - Offers a Software Development Immersive to boost skills
    - The course is open to anyone in the Department; however, for the October 2020 cohort, the primary audience will be Space Force members.
    - ONLINE: 6 months (3 months immersive, 3 months follow-on engagement)
    - No previous experience necessary, however, there is an entrance assessment that requires some programming skills (prep work is available).

I. TESTING AND EVALUATION (BOUND BY SOFTWARE)

LinkedIn Learning

- ONLINE: NOT FREE
- Offers over 70 courses on software testing
    - 31 BEGINNER courses
    - 41 INTERMEDIATE courses
    - 7 ADVANCED courses

Software Engineering Institute

- Acquisition Essentials for Software Reliant Systems
    - ONLINE: 1 hour ($75)
    - Challenges/failures of software development and acquisition of software-reliant systems have been well documented. There are many reasons software-reliant acquisitions fail, including unrealistic estimates, overly ambitious requirements, and inadequate software engineering and testing.
    - This course is part of a series of e-Learning modules to acquaint acquisition staff with key aspects of software-reliant systems acquisition. This course provides an

overview of three fundamental software acquisition topics, Software Requirements, Software Architecture, and Software Testing.
- There is an SEI Acquisition Team.

Udacity

- Software Analysis & Testing
  - ONLINE: 16 weeks (FREE)
  - INTERMEDIATE
- Software Testing: How To Make Software Fail
  - ONLINE: 1 month (FREE)
  - INTERMEDIATE

Udemy

- ONLINE: NOT FREE
- Offers over 500 courses in software testing (example below)
  - Become a Software Tester: Learn Software Testing & Get a Job
    - ONLINE: 1.5 hours ($94.99)
    - BEGINNER

III. ON-THE-JOB TRAINING

Air Force Education With Industry

- Part of the Air Force since 1947. The Air Force EWI Program is a highly selective, competitive, career development program designed to improve the technical, professional, and management competencies of participating students by partnering with top tier public and private sector companies. During the ten month tour, students embed with an industry team to meet their specific career desired learning objectives. Through hands on exposure to industry best practices, students develop the necessary competencies, skills, knowledge, and abilities to build, sustain and retain a mission-ready workforce, as well as learn how to better partner with industry in the future. The Program is sponsored by SAF/AQ and managed by the Air Force Institute of Technology (AFIT). (FROM WEBSITE)

AFVentures Fellowship (NEW in 2020)

- The Air Force, in partnership with AFWERX, initiated a 6-week fellowship program (similar to EWI, but much shorter) for airmen to participate in Silicon Valley companies.

Army Training with Industry (TWI)

- This program is a work-experience program to provide an extensive exposure to managerial techniques and industrial procedures within corporate America to competitively selected officers. The Army Acquisition Corps offers this assignment to highly motivated and skilled officers in the grade of O3-O5. Applicant backgrounds are matched up against desired and required skills of the specific companies. Training received is normally not available either through the military school system or civilian university system (FROM WEBSITE).

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Cyber Information Technology Exchange Program (CITEP)

- CITEP is the temporary exchange of DoD and private sector employees who work in the field of information technology between the two sectors. Personnel details range in length from 3 months to 1 year and encompass a wide range of mission critical areas. CITEP is not a 1-for-1 exchange of personnel. Instead, it is an opportunity for the exchange of knowledge, experience, and skills between the DoD and private sectors. Private Sector includes nonpublic or commercial individuals and businesses, nonprofit organizations, academia, scholastic institutions, and nongovernmental organizations (FROM THE WEBSITE). CITEP is authorized by S.2943 - National Defense Authorization Act for Fiscal Year 2017 114th Congress (2015-2016).

Dojos

- Dojos are a "space that is designed to host an immersive learning experience where full-stack teams come to learn modern engineering, product, and Agile practices. Teams participate in Dojo experiences, typically referred to as a "challenge." In these challenges, team build real products and work from their actual backlogs with the entire process while being led by a Dojo coach. The work process within the Dojo is typically comprised of hyper sprints, a common pattern of two-and-a-half-day sprints over twelve sprint cycles (i.e., six weeks). From Ross Clanton, Jaclyn Damiano, Carmen DeArdo, John Esser, and Eric Passmore, "Getting Started with Dojos: A Dojo Handbooks" (Portland: IT Revolution, 2019), 4. Each dojo is unique. To learn more about dojos, please see the Dojo Consortium and "Getting Started with Dojos."
- **NEW!** Platform One launched "Dojo DoD" in July! Fill out an interest form here.

Navy

- Training With Industry is a 12-month program providing Supply Corps lieutenants and lieutenant commanders with the opportunity to represent the United States Navy while serving as interns with some of the top corporations in the nation. Officers selected for this program are exposed to executive level decision-making at a Fortune 500 Company and will expand their professional supply and logistics education. These companies include Starbucks Coffee Company (Seattle, WA), The Home Depot (Atlanta, GA), FedEx (Memphis, TN), and ExxonMobil (Houston, TX). (FROM WEBSITE). See the SECNAV Instruction 1320.1A here

Platform One and DevSecOps Initiative

- A six-month residency available to military and civilians (federal)
- In October 2020, the Deputy Commandant Information, IC4 formally solicited the residency opportunity to all Marines by releasing a MARADMIN

Public-Private Talent Exchange Program

- The Public-Private Talent Exchange (PPTE), as articulated in Section 1599g of title 10, U.S.C., allows the Secretary of Defense, with the agreement of a private-sector organization and the consent of the employee, to arrange for the temporary assignment (detail) of a DoD civilian employee to that private-sector organization, or an employee of their private-sector organization to the DoD. An assignment will not be less than 3

months and may not exceed 2 years. Extensions beyond 2 years and up to a total of 4 years may be made to meet critical mission or program requirements.

SecDef Executive Fellows

- The Secretary of Defense Executive Fellows (SDEF) program was established by the Secretary of Defense in 1994 as a long-term investment in transforming our forces and capabilities and, as such, is a key part of the Department of Defense (DoD) strategy to achieve its transformational goals. Fellows have been assigned to such diverse and innovative businesses as: 3M, Accenture, Amazon, Amgen, Apple, Boeing, Booze Allen, Caterpillar, Cisco, DuPont, ExxonMobil, FedEx, General Dynamics, Google, Honeywell, Hewlett-Packard, Intel JPMorganChase, Lockheed Martin, Merck, Microsoft, Morgan Stanley, Northrop Grumman, Oracle, Raytheon, Salesforce.com, SAP, Shell, Southern Company, SpaceX, Union Pacific, United Technologies, and more (FROM THE SECDEF FELLOWS WEBSITE).

IV. BADGING/CERTIFICATIONS/CREDENTIALING

Amazon

- Amazon Training and Certification: Offers both digital and classroom training. Content is built by experts at AWS and updated regularly to keep pace with AWS updates. Focuses more on Amazon skills… there is FREE digital training.
    - Learning paths by role include cloud practitioner, architect, developers, and operations. Learning paths by solution include databases, machine learning, media, and storage.
    - The developer learning path is designed for software developers who want to learn how to develop cloud applications on AWS. Build technical skills as you progress along the path toward AWS Certification. More developer training is available here (both online and virtual).

Defense Acquisition University

- DAU offers credentialing in the following:
    - Agile: DoD Team Member
    - Data Analytics for DoD Acquisition Managers
    - Digital Engineering: DoD Consumer
    - Services Acquisition Team Member: Non-Acquisition Professional
    - Services Acquisition Team Member: Acquisition Professional
    - Program Protection

Digital University

- There are "badges" for gaining competency in a particular skillset

Google

- Google Developers Training is a set of online coding courses created by Google engineers. Google Developers Certification and Grow with Google also offer multiple certifications.

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- Like Google's existing IT Support Specialist Certificate offered through Coursera, this will probably take 3-6 months but students go from BEGINNER to job ready
- NOT FREE, but according to an article, the IT program is about $49/month
    - Associate Android Developer
    - TensorFlow Developer
    - Google Cloud Certified – Professional Cloud Architect
    - Google Cloud Certified – Professional Data Engineer
    - Google Cloud Certified – Associate Cloud Engineer
    - IT Support Specialist Certificate → **Available Now ($49/month)**
    - Data Analyst Certificate → **Coming Soon!**
    - Project Manager Certificate → **Coming Soon!**
    - UX Designer → **Coming Soon!**

IBM

- IBM offers badges to make training more fun. Some of the entry level badges are mere minutes long. Some are an hour or 4-8 hours with a quiz at the end. Some are classroom based, but most are online. Badging does help with promotion.

Linux Foundation

- The Linux Foundation is the only source for several open source certifications, including the Certified Kubernetes Administrator and Certified Kubernetes Application Developer

Microsoft Certifications

- Microsoft offers a variety of technology certifications from BEGINNER to ADVANCED. Certifications are NOT FREE.
    - Developer
    - Administrator
    - Solutions Architect
    - Data Engineer
    - Data Science
    - AI Engineer
    - DevOps Engineer
    - Security Engineer

Salesforce

- Salesforce Trailhead is an online tool that allows users to learn in-demand skills, earn certifications, and join the community for networking and mentorships. At the Fedscoop Workforce Summit, this program was presented as being a fun, easy way to learn new skills through certification and credentialing.
    - There are courses/certification for Salesforce developers: Modules include learning skillsets in leadership, google, AI, app building, management, Amazon, and GitHub. More courses are available here.
    - Salesforce presentation from 2019 Fedscoop Workforce Summit.

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Scrum Alliance

- Scrum Alliance offers a variety of certifications such as certified scrum master, certified scrum product owner, and Agile leadership (middle of the page).
    - Course can be very expensive, somewhere under $1000

The Software Alliance (BSA)

- Software Asset Management (SAM) Certification
    - BSA offers the **only** training and certification program in the world aligned to ISO 19770-1, the global standard for managing IT assets
    - ONLINE: $299 for individuals (prices change); $249 for team

V. COACHING/MENTORING

Federal Coaching Network

- Office of Personnel and Management, in partnership with Chief Learning Officer's Council, supports a multi-agency Federal Internal Coach Training Program.
- See FAQs

Scrum Alliance

- Scrum Alliance offers certification in coaching (bottom of the page)

VI. RELATED COMMUNITIES OF PRACTICE

Airmen Coders

- Organized by Airmen coders

Department of Defense Enterprise DevSecOps Community of Practice

- Co-led by the Department of Defense Chief Information Officer and Office of the Under Secretary of Defense for Acquisition and Sustainment

Digital.gov Communities of Practice

- Managed by General Services Administration

FFRDCs (Federally Funded Research and Development Centers)

- Not-for-profit entities sponsored and primarily funded by the U.S. government to address technical needs that cannot be met as effectively by existing government or contractor resources. **List of FFRDCs:** https://defenseinnovationmarketplace.dtic.mil/ffrdcs-uarcs/

IT/Software Community of Practices Videos (by Matt Kennedy, Treasury Department)

- Agile Acquisition 101
- Contracting for Change
- Complexity Level Contracting
- Capacity-Team Based Approach

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

Marine Coders

- A non-official organization comprised of Active Duty/Reserve Marines, Marine Veterans, and U.S. Citizens who want to help Marines through code
- See a Fedscoop article about how Airmen Coders and Marine Coders learn from each other

Navy Software Community of Practice

NavalX

- Serves as the Department of Navy workforce "super-connector," focused on scaling non-traditional agility methods across the DON workforce. The Naval culture of decentralized autonomy has been described as an innovation landscape marked by isolated and short-lived bursts of success. The approach is to connect to these isolated pockets of excellence to capture and scale the methodologies being employed, increasing awareness of cross-DoD and external successes, lessons learned, and subject matter experts.
    - Resources (collection of best practices) and training (specific training can be requested). Resources include playbooks (e.g., implementing Agile scrum and upcoming playbooks such as Agile tools), links to communities of practice, and toolboxes.
    - Through NavalX, the Centers for Adaptive Warfighting provides warfighter-ready courses in industry best practices, and supporting grassroots adoption, in order to drive change at all levels. See an article about the centers here.

Supra Coders

- Similar to Airmen and Marine Coders, but coders are specifically from U.S. Space Force

UARCs (University-Affiliated Research Center Laboratories)

- Not-for-profit entities sponsored and primarily funded by the U.S. government to address technical needs that cannot be met as effectively by existing government or contractor resources. **List of UARCs:** https://defenseinnovationmarketplace.dtic.mil/ffrdcs-uarcs/

VII. OTHER RESOURCES

Levels.Fyi

- See and compare the career progressions for software engineers, software engineer managers, data scientists, product managers, etc., for most major software companies

Videos (some resources also listed on the Air Force Chief Software Officer site)

- Kafka/KSQL (message bus, pub/sub, event driven):
    - Beginners
    - Intermediate
    - Advanced: N/A
- Kubernetes
    - Beginners
    - Intermediate
    - Advanced

Disclaimer: These resources are being provided for informational purposes only; they do not constitute an endorsement or an approval by the Department of Defense.

- Service Mesh
  - Beginners
  - Intermediate
  - Advanced
- Microservices
  - Beginners
  - Intermediate
  - Advanced
- Acquisition Talk
  - Lt Sean Lavelle recently spoke (April 20, 2020) on this podcast about "making the future of Navy software happen."

Books

- *Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations* (2018)
- *A Seat at the Table* by Mark Schwartz (former CIO of USCIS, leader in Agile): This book is highly recommended for ALL leadership as it is not technical but focused on the challenges around business, procurement and how leadership can enable DevOps across the organization and remove impediments.
- *The Phoenix Project* by the founders of DevOps
- *The DevOps Handbook* by Gene Kim, Patrick Debois
- *More Effective Agile* by Steve McConnell

APPENDIX H: Training Implementation Plan for Software Acquisition Professionals

Objective

In support of the FY20 NDAA Sec. 862 Software Developer and Software Acquisition Training and Management Program, the Defense Innovation Board (DIB) provided recommendations in their analysis of the Initial Draft. In which the DIB encouraged the Software Workforce Working Group (SWWG), *to continue their efforts and to identify ways to move toward implementation more quickly...take an innovative approach toward transformation...start small and iterate quickly.*

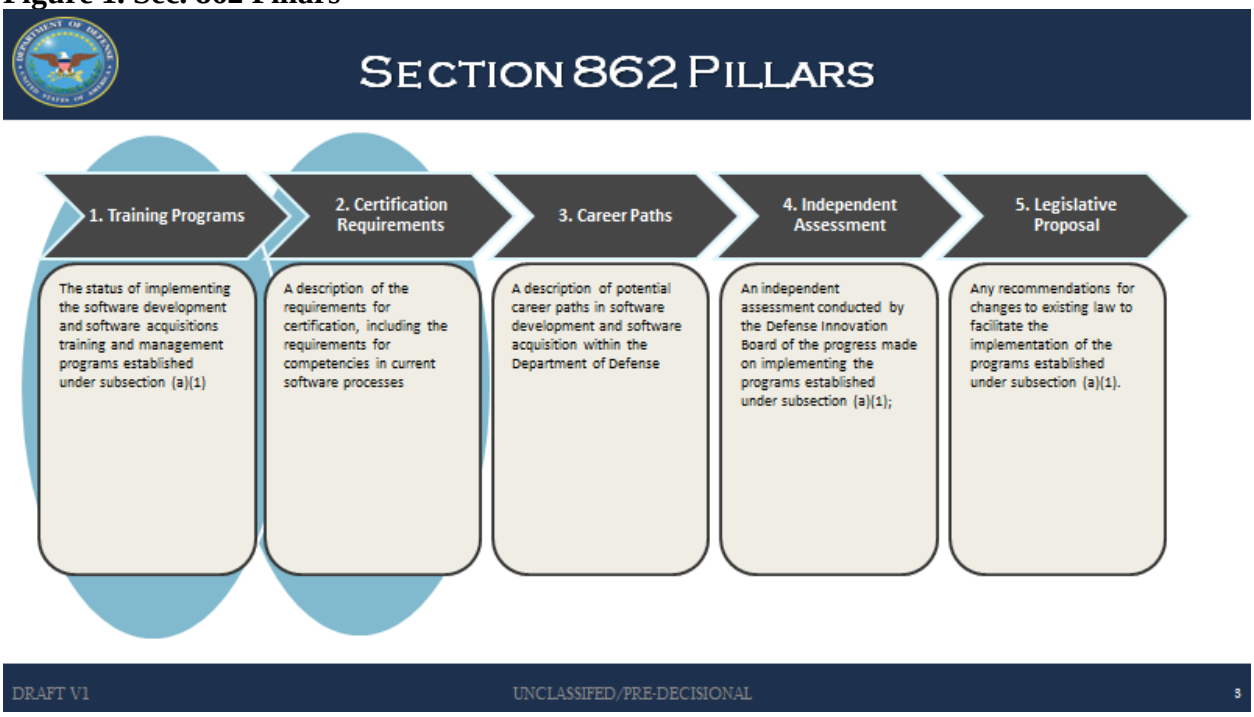
In response the SWWG scoped the following incorporating agile practices and processes utilizing an adaptation of the Lean Canvas and implementation recommendations in *Running Lean* by Ash Maurya.[1] "The Lean Canvas is a business model validation tool...that helps to document the business model, measure progress and communicate learning with internal and external stakeholders."[1] The first eight sections align to an adaptation of the Lean Canvas, the final section utilizes the lean canvas to inform our initial hypothesis and proposed implementation plan:

1. Users
2. Problem
3. Solution
4. Unique Value Proposition
5. Channels (Paths to Customers)
6. Key Metrics
7. Unfair Advantage
8. Cost Structure
9. Hypothesis and Way Forward

The SWWG believes by leveraging the adaption of the lean canvas will support definition and documentation of our assumptions and serve as the foundation for our agile learning processes and practices. This document intentionally provides further detail to serve as a standalone document. We believe through this process we can and will address the components highlighted in FY20 NDAA Sec. 862, as shown in Figure 1:

[1] Ash Maurya and Ash Maurya, *Running Lean* (O'Reilly, 2013).

Figure 1. Sec. 862 Pillars



1. Users

A user is defined as someone who will leverage the proposed solution. The goal of this section is to define the potential users. As highlighted in the main report FY20 NDAA Sec. 862 Roles and the DoD workforce, the Software Workforce Working Group (SWWG) proposed two categories that are intended to encompass multiple roles: software acquisition professionals and software practitioners

This appendix focuses on the **Software Acquisition Professional** defined as: *a member of the DoD acquisition workforce who provides expertise in the procurement, management and/or development of software intensive processes and systems such as business systems, weapons systems, supplies, or services to satisfy DoD needs and support military operations.* This training can be leveraged by software practitioners within software acquisition professionals, but is targeted to be more geared towards the software acquisition roles listed below:

- Example software acquisition roles to be targeted include: program managers, financial managers, contracting officers, and logisticians, which aligns to 4 of 6 “Back-to-Basics” (BtB) functionals.
    - FY20 Sec 255 is defining software competency and training for engineering and test and evaluation (software practitioners within software acquisition professionals)
- These roles above are representative of members who are not directly supporting product delivery but rather support the ability of valuable capability delivery through navigation and leveraging of the DoD 5000.02 Adaptive Acquisition Framework (AAF), Federal Acquisition Regulation (FAR), DoD 5000.74 Financial Management Regulation (FMR)

and other policies and regulations DoD and service-specific that guide the acquisition workforce.

The **early adopters** are program managers and contracting officers that best represent the target users as identified by the Service Acquisition Executives (SAE).

As highlighted in the final Sec. 862 report the ability to deliver valuable capability leverages multiple communities and roles. The intent is that the training developed will be provided to other relevant communities--i.e., Requirements and Planning, Process, Budgeting and Execution Processes within the Defense Acquisition System, as a potential building block for their training and curriculum development to develop a robust DoD software workforce prepared to meet today's needs and tomorrow's threats.

2. The Problem

With the identification of the users, the corollary is defining the problem from the user perspective. The goal of this section is to identify the problem(s) for software acquisitions professionals. The initial FY20 Sec. 862 report stated:

> *In current defense acquisition training and management programs, knowledge of and experience in the fundamentals of modern approaches are in short supply, and acquisitions professionals like program managers and contracting officers often have limited familiarity with software and Agile development practices...These shortfalls add risk to DoD's efforts to deliver quality software capability in a timely manner.*

Our military advantage is dependent on our ability to have intellectual parity with industry to ***minimally*** be smart buyers.

The top problems for Software Acquisition Professionals are:

1. No current adequate training exists that aligns the practices and process of modern software development and the Defense Acquisition System (DAS) tailored to roles of the software acquisition workforce
2. Unable to easily identify the software acquisition workforce across all BtB functions: program management, contracting, financial management, logistics, engineering and test and evaluation
3. Urgent capability need and execution of programs (or portfolio) is often prioritized over additional professional development
4. Within the program office it is often difficult to be aware, to manage and track the changing guidance and policies
5. Many lack access or unable to establish a recurring feedback loop with operational users of the software and digital capability that provides useful insight to shape the acquisition in a way that best suits the mission need
6. Similar to guidance and policies, lack of transparency on available enterprise services that can enable software capability delivery and reduce duplication of effort and silos

An alternative problem statement: Our software acquisition workforce remains difficult to identify, lacks easily accessible and actionable training that aligns the practices and process of modern software development and the DAS.

Current Existing Alternatives for Acquisition Workforce.

The following list is not inclusive of all options, but rather focuses on available training targeted for acquisition professionals. There are multiple service-led efforts that are not mentioned because they are not currently available widely across services. The goal of identifying Current Existing Alternatives is to ensure that the proposed solution addresses a capability gap that is currently not addressed.

- DoD Training Opportunities:
    - Defense Acquisition University (DAU) is currently providing alternative training to address the problem highlighted in (1) to include:
        - Credentialing in Agile
        - Coursera/DAU Partnership
    - Defense Playbooks
        - OSD Agile Guidebook based on FY18 Sec. 873/874 Pilots
        - United States Digital Services (USDS) Digital Services Playbook <https://playbook.cio.gov/>
- Additional Federal Training Opportunities:
    - Open-source Defense IT Acquisition Professional (DITAP) provided by United States Digital Services (USDS) and Office of Federal Procurement Policy (OFPP) to support Federal Acquisitions Certification in Contracting Core-Plus Specialization in Digital Services (FAC-C-DS)[2]

3. The Solution

The following is the proposed solution to address the problems identified (Section 2) with respect to the identified users (Section 1). This solution is the foundation of our hypothesis and way forward that outlines how we will test, and will further be refined in the following sections. To best address the problems identified, the following addresses both the content of training and also experiments with the delivery method.

Training Content.

The proposed solution is for the DoD to leverage existing, tested, and open-source training: Defense IT Acquisition Professional (DITAP) Curriculum, as referenced in Current Existing Alternatives, as a foundation.

- *Why DITAP?* DITAP was created to address a similar problem as identified above. That is, DITAP was built in response to a OFPP and USDS issued challenge to industry in 2015: to transform how the government builds and buys digital services, and to create and pilot a training and development program that transforms how Federal Contracting

[2] https://www.whitehouse.gov/wp-content/uploads/2018/05/fac_c_digital_services_05_12_18.pdf?utm_medium=email&utm_source=govdelivery.

Professionals procure digital services. Since the first course in 2018, DITAP has continued to train and certify contracting professionals across other federal agencies. DoD interfaces with DITAP-trained contracting professionals when engaging with Defense Digital Services (DDS).

DoD DITAP MVP. The assumption is DITAP will be at least 70% of the DoD solution. DITAP does not address unique DoD policies and statutes since it was not created for the DoD. Furthermore, it must be adequate for software acquisition roles beyond contracting, i.e. program managers, financial managers, etc. Section 9 addresses the implementation plan to test content and delivery.

Proposed Training Content. Modularize DITAP and incorporate DoD-specific policies and regulations (i.e. DoD 5000.02 The Adaptive Acquisition Framework, Defense Federal Acquisition Regulation Supplement (DFARS), and DoD 5000.74 Financial Management Regulation (FMR), etc.).

Training Delivery.
In addition to validating the proposed training content, the assumption is that it is necessary to provide the multiple avenues to achieve certification--self-paced online courses, instructor-led virtual courses, or a combination. This allows for training to be tailorable to individual learning preferences and/or time availability for training.

Training Availability.
After initial pilot, if successful, and with the support of DAU, the goal is to have the competencies, curriculum and training available to all acquisitions professionals

4. Unique Value Proposition

The Unique Value Proposition identifies why the proposed solution is different and why it is worth investing the necessary time and resources.

- Training Content. Utilizing DITAP as a foundation--assumed 70% solution, will help to accelerate implementation and training content availability.
- Training Delivery. OUSD(A&S) in coordination with the Service Acquisition Executives is identifying an initial cohort for training (Section 9).

High-level concept.
Provide an easily accessible and tailorable training to support the development of digital services procurement and management strategists that incorporates agile learning.

5. Channels (Paths to Customers)

To start small and iterate, and to meet the initial goal of learning vice scaling the SWWG proposes an initial cohort that will be foundational for the opportunity for scale as the approach to channels (paths to customers). This will provide the opportunity to receive the input and feedback on training content and delivery method to inform the approach for scaling to the DoD Acquisitions workforce.

Initial Cohort.

To date, the SWWG has been working with the Service Acquisition Executives (SAEs) to identify the initial cohort. To inform scaling, the initial cohort proposed will be composed of notionally three separate course offerings of no more than 20 software acquisition professionals. The initiation of the pilot is 1 Nov 20 with the curriculum of Release 1 for the first offering. The second and third offerings will occur after the end of CY20. This will enable input and feedback on the training content and delivery method to be immediately incorporated which will be foundation to the DoD Acquisition Workforce as this continues to scale.

Scaling Proposal.

The proposal for scaling addresses important aspects to ensure we address the totality of the software acquisition workforce. The scaling plan will be informed by feedback from the first three offerings in the initial cohort.

6. Key Metrics

The following metrics are intended to not only ensure completion of training but also to ensure training content and delivery empowers the software acquisition workforce to serve as an accelerator and enabler for valuable software capability delivery.

The key metrics proposed are:

- Course Completion / Training Certification
- Employee Satisfaction

Below defines the key metrics, the intended behavior they are trying to measure, ways that the metric can be improved (increased), how it is gamed (how can it be over-inflated or over-emphasized) and finally what occurs if the metric is over-emphasized. This framework aligns with an industry example to define metrics in terms of positive and potentially negative incentives that can be associated with an individual metric.

Course Completion.

Proposed Metric	**Course Completion**
Definition	Provides status on completion per course and student (identified through their role/position/functional) and percentage of course completed relative to average completion time for online and in-person courses.
What is the intended behavior?	Provides an overall site picture of courses and status of roles to training plans across enterprise
How is it improved?	-Increased enrollment -Recommends class to peers -Options for fulfillment

How is it gamed?	-Can only increase, thus with changing workforce can exceed those that need to be trained -Does not indicate understanding, can provide false security of workforce improvement
When overemphasized what are potential corollary impacts? (i.e. other metrics affected)	-Completion vs. Understanding -Utilization Rate overstating value

Employee Satisfaction.

Proposed Metric	**Course Completion**
Definition	Provides qualitative data on how actionable the training content and delivery is. The employee satisfaction surveys are conducted informally throughout training, but also formally at the following intervals: -Completion of Training Curriculum -3 months after Certification -6 months after Certification The additional extended feedback loops provide an opportunity to assess whether the training is actionable and positively impacts valuable capability delivery.
What is the intended behavior?	To validate (or invalidate) the training content and delivery method to inform future training.
How is it improved?	-Transparent incorporation of prior feedback -Tailoring coursework and delivery to individuals -Access to facilitators and instructors regardless of delivery mechanism
How is it gamed?	-If delivery of feedback is not intentional, can be a completion exercise that over conveys the value of the training -Feedback or satisfaction can be representative of extreme views
When overemphasized what are potential corollary impacts? (i.e. other metrics affected)	-Only represents a fraction of workforce and could drive changes in content and delivery that are not beneficial

7. Unfair Advantage

Examples of unfair advantages include: the right 'experts' endorsements, a dream team, large network effects, community, etc.[3]

In support of development of the proposed plan, the SWWG has worked to establish feedback loops across the Department. OUSD(A&S) has led engagement with the SAEs to solicit leadership input and to inform strategy. The above strategy and the way forward are based on these engagements and have provided the endorsement necessary to pursue the initial cohort.

Furthermore, the opportunity exists for maximum network effects and community by leveraging the responsibility of OUSD(A&S) to lead acquisition workforce development and training. *What got us here, will not get us there*; experimenting with different modes of delivery will allow us to assess what provides the most value to our users and how it impacts the missions they serve. The SWWG as led by software experts in OUSD(A&S) can partner with DAU and the services to ensure that the training delivery is tailored and best suited for the workforce.

8. Cost Structure

By leveraging an available open-source training as a foundation lowers the initial cost of the pilot. To implement with the initial cohort as proposed above in channels, the intent is to leverage current DoD employees and FFRDC support to initial field the content and to facilitate and instruct. As scaled, the costs may increase to ensure that the content is accessible and remains relevant. Throughout the initial cohort a cost estimate will be developed with approaches taken to prevent cost growth. A best practice from the DITAP training implementation was leveraging prior students/graduates as facilitators and trainers, to support both incorporation of relevant roadblocks and best practices but also is another way to ensure understanding.

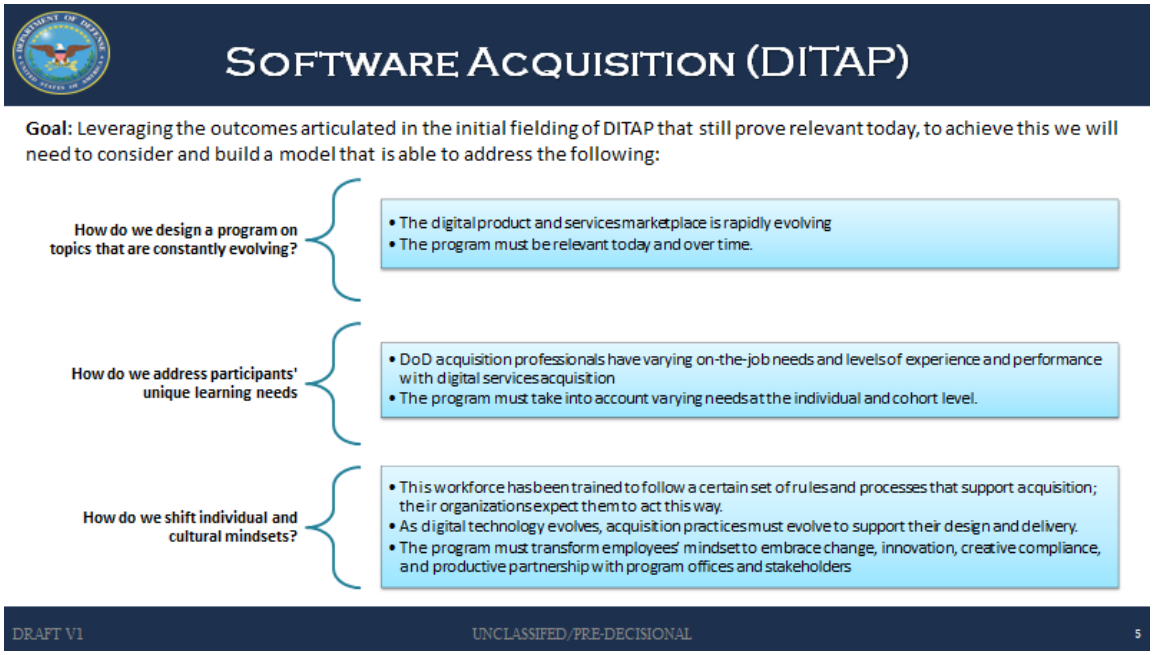
"Teaching is the highest form of understanding.' –Aristotle

8. The Hypothesis and Way Forward

Mirroring the experiment and intent pioneered by the curriculum for DITAP, the following Minimum Viable Product (MVP) for the DoD-adaptation of DITAP aims to transform the way the DoD builds and buys digital services so that:

- We become better digital procurement experts
- Are equipped with the knowledge necessary to be imbedded within agency Digital Service teams to serve as a business advisor to the team, it's customers, and its stakeholders
- Have the ability to lead workshops that expand digital services knowledge across the respective teams the impact

[3] Ash Maurya and Ash Maurya, *Running Lean* (O'Reilly, 2013).



Agile Learning.

In addition to the open-source training curriculum and coursework provided through DITAP, USDS and OFPP documented instructional components to support the transition and adoption of DITAP by federal agencies. The application of this is critical for the DoD. The DoD is trying to transform the way it builds software solutions that support the business and mission aspect of all we do. It's important to realize that we cannot do this alone. We have outsourced some of our largest systems and our procurement process can be one of our biggest hurdles to overcome.

We need a better mechanism that enables us all to transport a user's need into digital outcomes. If we subscribe to the model USDS built DITAP upon, we are procuring product, code, and data - we are not procuring comprehensive test and project plans. Throughout the duration of this process the goal will be to change how we view acquisitions and procurement processes and how to best leverage current regulation and laws to support software and digital technology.

DITAP implementation recommends the following: *Given the overall challenge outcomes and the three specific challenges described above, we designed a program using agile learning design, in which we: (1)* ***build*** *instruction in segments,* ***measure*** *it using regular assessments, and* ***learn*** *in an iterative fashion, and (2) fix some performance objectives/instruction (60%) while allowing the remainder of the instruction (40%) to flex to address individual and cohort learning needs.*[4]

The following MVP incorporates these recommendations, and as documented throughout we intend to establish the necessary feedback loops to ensure that we can measure and learn to continually improve.

[4] The Office of Management and Budget, *Digital Service Contracting Professional Training and Development Program Challenge Transition Plan* (September 2015).

MVP Competencies and Proposed Curriculum.

The following utilizes the DITAP training competencies, curriculum, and course content, each module henceforth referred to as a release as a tribute to agile.

Competency Summary.

Competency	Performance Outcome
1. Digital Services in the 21st Century Government	Describe digital services in the 21st century, including what they are, who provides them, how they are delivered, and why they are important
2. Digital Foundations*	A more in-depth review of the practices, processes, and concepts currently implemented by industry to support modern software development and continuous delivery
3. Understand What You Are Buying	Determine the problem to be solved while effectively supporting and communicating with the customer and industry
4. How do you buy	Effectively use techniques for acquiring digital service solutions in your solicitation or acquisition strategy
5. Awarding & Administering Digital Service Contracts	Conduct and award digital service contracts, using and applying metrics and incentives appropriately, and applying proper course correction when necessary

*NOTE: Digital Foundations is the only additional competency introduced. Competencies 1, 3, 4, and 5 will heavily leverage the currently available open-source training. The additional content modifications for those sections will incorporate the DoD specific policies

The following is the proposed curriculum and the planned content to be incorporated to create the DoD DITAP MVP for the first group within the initial cohort:

Release 1: Digital Services Landscape and Agile

Release 1: Digital Services Landscape and Agile				
Curriculum Release	**Module**	**Perf Obj**	**Performance Objectives**	**Performance Outcomes:**
Digital Services in the 21st Century Government	1.1 The Digital Services Professional	1.1A	Define digital services and the problems they can be used to solve.	Describe digital services in the 21st century, including: what they are, who provides them, how they are delivered, and why they are important
		1.1B	Identify key digital services roles/professionals in the digital services ecosystem and their challenges.	
		1.1C	Identify modern design, development, and delivery methods used by digital services professionals.	
		1.1D	Identify "who's who" in the digital services arena, including public and private sector organizations and individuals.	
		1.1E	Illustrate your new role as a digital service acquisition professional and that of your team members.	
	1.2 The Digital Services World	1.2A	Identify the available sources of supply within the digital services market segments, such as Open Source Software, Big Data, Xass, Cloud, and more.	
		1.2B	Identify the high-level principles of agile development that make it effective.	
		1.2C	Describe what sets agile methods apart from waterfall development and delivery methods.	
		1.2D	Define different types of acquisiton solutions that can be used to acquire digital services	

Module 1.1 The goal will be to focus on the digital service professional and understanding:

- What digital services are
- Who provides them (individuals, vendors, government)
- How they are delivered (e.g., processes/methodologies like Agile and DevSecOps as well as tools and technologies used by digital service teams)
- Why successfully buying and delivering them is so critical

Module 1.2 - The goal will be to explore available sources of supply, while considering how to introduce non-traditional vendors to the DoD marketplace.

Release 2: Digital Foundations

This is an addition to the original DITAP training. This is an opportunity for our workforce to dive deeper into DevSecOps as the DoD CIO has issued the DevSecOps Reference Design. The module title above shows the foundations that will be provided.

Release 2: Digital Foundations				
Curriculum Release	**Module**	**Perf Obj**	**Performance Objectives**	**Performance Outcomes:**
Digital Foundations	2.1 The Emergence Story of DevSecOps	2.1A	Define the emergence story of DevSecOps	• Explain the drivers responsible for the emergence of DevOps • Define and Discuss the key concepts and Principales of DevOps. • List and explain the business benefits of DevSecOps and continous delivery • Know how teams can translate DevSecOps Principles into tangible practices. • Learn about modern operations in a DevSecOps context. • Explain the concepts of test automation, infrastructure automation, and build and deployment automation. • Describe how DevOps relates to Lean and Agile methodologies. • Get insight into the various organizational DevOps models • Identify how Cloud and Delivery pipeline automation optimize and accelerate the ways of working. • Discuss the critical success factors for DevOps transformation.
		2.1B	Define how DevSecOps has evolved	
		2.1C	Identify organizational benefits for DevSecOps	
		2.1D	Analyze what should be considered when executing DevSecOps	
	2.2 DevSecOps for Individuals	2.2A	Identify why T Shaped profiles important to DevOps?	
		2.2B	Define the roles on a DevSecOps Team	
		2.2C	Identify your knowledge gaps as a DevSecOps Team Member	
		2.2D	Develop a learning journey to bridge those gaps	
	2.3 DevSecOps for Teams and Organization	2.3A	Describe the culture of a DevSecOps team and organization	
		2.3B	Illustrate how a DevSecOps team should behave	
		2.3C	Define why it's important to have autonomy in DevSecOps Teams	
		2.3D	Analyze why scaling is enevitable	
		2.3E	Identify why it's important to measure success to improve	
	2.4 DevSecOps Practices	2.4A	How does a the Lean approach help DevSecOps organizations achieve maximum value	
		2.4B	How does the agile approach help DevOps organizations achieve maximum customer value	
		2.4C	How should a DevSecOps organizations be structured - The Conway's Law to Microservices Architecture	
		2.4D	What is the role of ITSM practices within DevSecOps enviornment and how these two can be integrated effectively	
		2.4E	How DevSecOps organizations can work with modern infrastructure such as Cloud.	
		2.4F	Identify how DevSecOps Organizations can practice Continous Integration/Continous Delivery	

Release 3: From User Need to Acquisition Award

Now that the groundwork has been laid, we will begin applying the knowledge using a case prescribed to the cohort or one the cohort brings to us.

Release 3: From User Need to Acquisition Award				
Curriculum Release	**Module**	**Perf Obj**	**Performance Objectives**	**Performance Outcomes:**
Understand What You Are Buying	3.1 Understanding Your Needs and Agency Readiness	3.1A	Analyze stakeholders in your sphere of influence that will impact digital services acquisition.	Determine the problem to be solved while effectively supporting and communicating with the customer.
		3.1B	Assess your agency's readiness for change and innovation.	
		3.1C	Analyze a digital service need to determine the most appropriate market for the service.	
		3.1D	Ask effective exploratory questions to understand the agency's need and make recommendations on a course of action for a digital acquisition procurement.	
	3.2 The Digital Services Market	3.2A	Identify why communicating openly and responsibly with potential vendors is critical to digital services acquisition success and how to do it.	
		3.2B	Differentiate between buying compliance and buying outcomes.	
		3.2C	Conduct effective market research for digital services.	
Curriculum Release	**Module**	**Perf Obj**	**Performance Objectives**	**Performance Outcomes:**
How do you Buy?	3.3 Developing an Acquisition Strategy	3.3A	Identify how to develop an acquisition strategy for digital services.	Effectively use techniques for acquiring digital service solutions in your solicitation or acquisition strategy.
		3.3B	Select an acquisition strategy that supports your customer's needs for a digital acquisition.	
		3.3C	Identify strategies and communication methods to apply at different phases of the change lifecycle.	
		3.3D	Identify evaluation methods and criteria on cost and pricing, terms and conditions, security concerns (cyber), and data rights to evaluate vendor maturity and ability to deliver a product that solves a given need and given the definition of success.	
	3.4 Acquiring Digital Services	3.4A	Identify the role that security plays in digital service contracts.	
		3.4B	Develop your acquisition package for procuring digital services, including proposal and source selection methods.	
		3.4C	Define evaluation criteria, given evaluation strategy discussed in your acquisition strategy.	

Module 3.1: It is important that we teach our acquisition professionals how to interact within the stakeholder environment. This will include not only the requirements owners but the discovery of users and their needs collaboratively. Here we will find out how ready the stakeholder and users are for change and innovative digital service practices.

Module 3.2: Now that the Stakeholder and User needs have been understood, the market segments that can potentially meet these needs can be assessed by teaching the community how to conduct responsible and effective pre-solicitation communication with potential vendors and suppliers within the marketplace.

Module 3.3: Here we will understand the approved pathways an acquisition team can take to develop an acquisition strategy and plan for agile and digital services. This will include:

- Pricing
- Security
- Evaluation Methods (and more…)

Module 3.4: This module will build upon Module 3.3 as the strategies will be applied while developing the SOW, SOO, or PWS, evaluation criteria, special technical and security considerations and all other elements of an acquisition package provided to the vendors.

Release 4: Digital Services Delivery.

Release 4: Digital Services Delivery				
Curriculum Release	**Module**	**Perf Obj ID #**	**Performance Objectives**	**Performance Outcomes:**
Awarding & Administering Digital Service Contracts	4.1 Awarding Digital Service Contracts	4.1A	Select a technical evaluation team with the necessary digital skills.	Evaluate vendors who deliver digital services using instantaneous, objective metrics on project health, developed via appropriately applied lean thinking and agile development methods while experimenting with flexible contract design and administration strategies.
		4.1B	Identify how to get the best value solution for your program by negotiating tradeoffs.	
		4.1C	Determine the next steps that follow contract award. (Kickoff, Ramp-up, Baselining)	
		4.1D	Identify the effective characteristics of a change agent and strategies to apply at different phases of the change lifecycle as you return to your agency.	
	4.2 Digital Services Delivery (or How Solutions Get Done)	4.2A	Identify software engineering practices for high-quality digital services like version control, continuous integration, and continuous delivery.	
		4.2B	Identify metrics creation and utilization to help identify when failure actually occurs.	
		4.2C	Determine how to execute an exit strategy and course correct.	

Module 4.1: Evaluate vendors who deliver digital services using instantaneous, objective metrics on project health, developed via appropriately applied lean thinking and agile development methods while experimenting with flexible contract design and administration strategies.

Module 4.2: While technology can evolve at a breathtaking pace, our Government practices do not. Here we will look at how private businesses have made strides in maximizing quality, while minimizing cost for shareholders. The Government has struggled to understand what this means within its own context; let's explore terms like Agile, Lean, DevOps, cloud, API, x-as-a-service, and Big Data emerge every day, but assessing their value to your agency amidst a haze of buzz and confusion is all but impossible when you have a core mission to accomplish and an ever-tightening budget. Discover how modern practices can inform the acquisition process to maximize value and quality and minimize cost and risk.

OFFICE OF THE SECRETARY OF DEFENSE
1000 DEFENSE PENTAGON
WASHINGTON, DC 20301-1000

MEMORANDUM FOR CHIEF MANAGEMENT OFFICER OF THE DEPARTMENT OF DEFENSE
SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
CHIEF OF THE NATIONAL GUARD BUREAU
GENERAL COUNSEL OF THE DEPARTMENT OF DEFENSE
DIRECTOR OF COST ASSESSMENT AND PROGRAM EVALUATION
INSPECTOR GENERAL OF THE DEPARTMENT OF DEFENSE
DIRECTOR OF OPERATIONAL TEST AND EVALUATION
CHIEF INFORMATION OFFICER OF THE DEPARTMENT OF DEFENSE
ASSISTANT SECRETARY OF DEFENSE FOR LEGISLATIVE AFFAIRS
ASSISTANT TO THE SECRETARY OF DEFENSE FOR PUBLIC AFFAIRS
DIRECTOR OF NET ASSESSMENT
DIRECTORS OF DEFENSE AGENCIES
DIRECTORS OF DOD FIELD ACTIVITIES

SUBJECT: Software Development, Security, and Operations for Software Agility

Reference: (a) DoD Enterprise DevSecOps Reference Design, August 12, 2019
(b) Software is Never Done: Refactoring the Acquisition Code for Competitive Advantage, Defense Innovation Board, May 3, 2019

In the 2019 Digital Modernization Strategy, the Department outlined numerous goals and objectives to improve information technology (IT) to increase our military advantage across all spectrums. One of the goals identified was to pursue the use of Software Development (Dev), Security (Sec), and Operations (Ops) or DevSecOps, as a software development methodology. The use of this commercial best practice will support the Department's efforts to ensure better utilization of Artificial Intelligence and Cloud Environments. Reference (a) is the Department's approved DevSecOps Reference Design Document outlining the preferred software practice for all Department of Defense (DoD) components to rapidly provide software agility "at the speed of operations". The Reference Design Document provides implementation and operational guidance to IT capability providers, IT capability consumers, application teams, and Authorizing Officials.

The current approach to software development is less than optimal and is increasingly a long-term risk to the Department's competitive military advantage. Current software development takes too long, is expensive, and exposes warfighters to unacceptable risk by delaying access to tools needed to ensure mission success. That assessment is consistent with the DoD internal analysis and multiple external reviews conducted over the years including the Defense Innovation Board. Adoption of the DevSecOps approach can enable a more effective joint force, strengthen our ability to work with allies, and improve the business processes of the DoD enterprise (reference (b)).

To broaden the use of this DevSecOps Reference Design, the DoD Chief Information Officer (CIO) and the Under Secretary of Defense for Acquisition and Sustainment (USD (A&S)) are engaging Department Authorizing Officials (AO) and cyber assessment communities to establish a framework to accept authority to operate (ATO) inheritance from the cloud, reciprocity from shared hardened containers, and the output of the continuous monitoring tools. Mature DevSecOps practices will lead to "continuous ATOs" for software and the underlying infrastructure. The DevSecOps Reference Design v1.0 is currently available at: https://www.milsuite.mil/book/groups/dod-enterprise-devsecops/.

The DoD CIO point of contact (POC) is Mr. Tom Lam, (571) 372-4686, or ngoan.t.lam.civ@mail.mil. The OUSD (A&S) POC is Dr. Jeff Boleng, (703) 571-9029, or jeffrey.l.boleng.civ@mail.mil.

Dana Deasy
Department of Defense Chief Information Officer

Ellen Lord
Undersecretary of Defense
for Acquisition and Sustainment