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Executive Summary

Background

The Defense Civilian Training Corps (DCTC) was authorized through the National Defense Authorization Act (NDAA) for Fiscal Year 2020 (FY20), Section 860 and U.S. Code Title 10, Chapter 113 (Section 2200), which directed the Secretary of Defense to establish and maintain a DCTC program. An initial implementation plan was produced in August 2020 by the Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD (A&S)) along with the Office of the Under Secretary of Defense for Personnel and Readiness (OUSD (P&R)). That plan described a program aligned with the National Defense Strategy with particular features (e.g., scholarship-for-service requirements, list of courses for a 4-year curriculum, initial areas of study). DCTC was not funded in the FY22 budget, so implementation plans were put on hold.

The Institute for Defense Analyses (IDA) was asked to design possible alternative options and associated costs for implementing the DCTC program.

Program Design Alternatives

Case 1 is a 4-year scholarship-for-service program where students complete a summer internship each year, take DCTC courses during the semesters at schools with a DCTC unit, and commit to work for the Department of Defense (DoD) after graduation. During the 4-years with their DCTC university cohort, the students would complete projects together and learn about how they can help the DoD address critical technology (CT) challenges. Case 1 is the original plan devised by OUSD (A&S) and OUSD (P&R).

Case 2 is a 2-year scholarship-for-service program where students complete a summer internship each year, take DCTC courses during the semesters at schools with a DCTC unit, and commit to work for the DoD after graduation. Case 2 is shorter than Case 1, which would save money and may reduce program attrition since students have already assimilated to college and their intended science, technology, engineering, and mathematics (STEM) degree plans, but has less total time for student development in their DCTC units and a shorter service commitment period. Additionally, Case 2 has the opportunity for continued development after graduation with an option where some students might seek a graduate degree, whereas Case 1 does not offer this opportunity.

Case 3 focuses on the skilled technical workforce (i.e., technical positions that do not require a bachelor's degree), a segment of the STEM workforce that does not receive as much attention or support for education as those working towards bachelor's or graduate degrees. Case 3 is a 2-year scholarship-for-service program for students at community colleges (or trade schools or certificate programs) who will complete a summer internship each year, take DCTC courses during the semesters, and commit to work for the DoD after graduation.

Case 4 focuses on the summer internships component of DCTC and also includes an abbreviated DCTC curriculum. The internships provide participants with real job experience to learn and work at DoD facilities, which may motivate them to join the DoD post-graduation. However, post-graduation employment is not a requirement in this Case since they are not receiving a scholarship (a program cost savings).

Case 5 is designed as a simplified program leveraging pre-existing programs, in which the DCTC curriculum is provided to other DoD programs (high school, community college, and undergraduate colleges) for use. The duration of the curriculum could be adjusted to fit into the leveraged program. The DoD already has several scholarship and internship programs, but none of those programs has a component like the DCTC curriculum. This Case would add value to those existing programs.

Each of the alternatives would have a curriculum component that would provide courses to help prepare and inform students about the DoD and how it works to maintain technological superiority. This would include instruction on how the DoD's innovation organizations are structured and how that delivers technology to warfighters; the science behind CT challenges; and active learning exercises and team/cohort projects.

Issues and Trade-offs

The relative value of the initial case as well as the alternative cases is influenced on the importance and weighing of the objectives DCTC is designed to address. Some of these relevant trade-off issues include:

- The DCTC curriculum could be adjusted in time and scope based on the resources allocated to the final program design selected. As currently envisioned, there is no other scholarship/internship programs that include such training.
- Internships provide a realistic job preview for students and allows the DoD to gain an extended understanding of interns. Cases 1–4 include internships, but vary in the number of years a student may participate in such opportunities.
- All Cases can be structured to increase representation by those traditionally under-represented. School selection could facilitate reaching under-represented groups for Cases 1–3, while targeted outreach and applicant selection can be used for all Cases.

- The costs for each Case decrease in order from Case 1 to 5.
- The value/cost of a commitment varies based on external factors (e.g., employment rate) and a longer/shorter or complete lack of commitment may fluctuate.
- The development of participant cohorts has benefits (e.g., esprit de corps, developing teamwork skills, building professional networks) and cohorts would be co-located in Cases 1 and 2 where distributed cohorts could be established in Cases 3–5.

Monitoring the DoD's shifting requirements to adapt the program as its needs change is something to consider for all Cases. This could include DoD priorities and most pressing CT challenges along with workforce needs for particular skill sets. This helps set the goals and objectives of the programs. The CT challenges of today may be solved and new technologies may be sought in the future. The skill sets needed by the future workforce are also likely to change over time, so assessing the skills and competencies needed will be required for selecting the right students and shaping the curriculum to optimize the DoD's investment in these students.

Conclusion

The DoD has an opportunity to create a unique workforce program to bring in talent to address CT challenges. The initial DCTC implementation plan (Case 1) has several features enabling the program to attract and develop students to take on CT challenges. These features have a cost (tuition and stipends) and a benefit (commitment of student to work at the DoD post-graduation), and the relative values may fluctuate over time based on the particular needs of the Department and interests and capabilities of students. Therefore, it is useful to consider alternative design plans as described in this report.

With each of the cases having its particular trade-offs, it is important to consider other programs for attracting talent to the DoD; such as the current standard hiring practice through USAJobs, which may include the use of direct hiring authorities to facilitate the process, along with some workforce recruitment programs that offer scholarships and/or internships. DCTC can be designed to bring new capabilities for attracting and training an innovative workforce, like the DCTC curriculum. Also, by tracking the DoD's CT and workforce requirements the program could be modified to best address it's needs. Such a program would enable the DoD to sustain a civilian workforce and maintain the United States' national defense technical superiority.

Contents

1. Introduction and IDA Tasking

The Defense Civilian Training Corps (DCTC) was authorized to be established in December 2019 through the National Defense Authorization Act (NDAA) for Fiscal Year 2020 (FY20), Section 860, and U.S. Code Title 10, Chapter 113 (Section 2200), which directed the Secretary of Defense to establish and maintain a DCTC program at civilian educational institutions authorized to grant baccalaureate degrees. The purpose of the program is to prepare students for public service in specific Department of Defense (DoD) occupations determined by the Secretary of Defense to address critical skill gaps.

An initial implementation plan for the establishment of the DCTC was produced in August 2020 by the Office of the Under Secretary of Defense (OUSD) for Acquisition and Sustainment (A&S) along with the OUSD for Personnel and Readiness (P&R). That plan described how the program would be aligned with the National Defense Strategy, described features of the program (e.g., scholarship-for-service requirements, list of courses for a 4-year curriculum, initial areas of study), and provided an execution schedule for the program to deploy units over its first few years. DCTC was not funded in the FY22 budget so implementation plans were put on hold.

In the spring of 2021, OUSD (A&S) asked the Institute for Defense Analyses (IDA) to outline possible alternative options and associated costs for implementing the DCTC program. In response, IDA leveraged its subject matter expertise in science, technology, engineering, and mathematics (STEM) education programs and workforce development to produce a series of implementation alternatives for the DCTC program, identified a curriculum to support training of a future DoD workforce with the critical skills and knowledge needed by the DoD, and provided guidance on key considerations regarding selection of participating or partnering colleges and universities. Accordingly, this report outlines details in the initial design as proposed in the NDAA and Title 10 while also presenting alternative approaches that may be more cost efficient and/or feasible while still achieving the goals set forth for the program. Additionally, the report contains some contextual data on the DoD workforce and university talent pool relevant to implementing a program like DCTC. The objective of this report is to describe a range of DCTC alternatives for implementation as well as the analyses and considerations used by IDA to develop the options.

2. Background

This section provides an overview of the statutes directing the creation of the DCTC and the associated implementation plan developed by two groups within the OUSD. Because the implementation plan outlines how the Senior Reserve Officers' Training Corps (often referred to as ROTC) and the DoD's Science, Mathematics, and Research for Transformation (SMART) Scholarship-for-Service Program will serve as models for DCTC, we provide a brief description of both programs. Additionally, to aid in the development of a methodology to identify and target critical skills gaps in DoD occupations relating to acquisition, science, engineering, or other priority occupations, we provide a description of both the DoD STEM workforce and the U.S. university talent pool.[1]

A. The Development of the Defense Civilian Training Corps

The NDAA for FY20, Section 860 amended Title 10, U.S. Code to add several new sections (2200g – 2200j),[2] directing the Secretary of Defense to establish and maintain a DCTC program at civilian educational institutions authorized to grant baccalaureate degrees. The DCTC program was directed to scale up to at least 20 accredited educational institutions with a minimum of 400 members enrolled in the program.

In response to the new requirement, the OUSD (A&S) along with the OUSD (P&R) produced an initial implementation plan for the DCTC in August 2020. This plan described the initial implementation design, methodological program elements and metrics (as directed in 10 U. S Code §2200g – 2200j), and specifics on how DCTC would align with the National Defense Strategy (excerpts of the initial plan are presented in Appendix A). As envisioned, DCTC would leverage the strengths of the ROTC and the SMART Scholarship-for-Service Program to address the DoD's ongoing need for scientists and engineers in a shorter amount of time. Program policies from both ROTC and SMART

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1 In the House of Representatives Committee Report on NDAA FY23, there was reference to the use of resources and programs of the Acquisition Innovation Research Center to implement the DCTC in consultation with various senior executives and officers with relevant experience and expertise. (https://www.govinfo.gov/content/pkg/CRPT-117hrpt397/pdf/CRPT-117hrpt397.pdf)

2 10 U. S Code §2200g – 2200j outlined Congress' intended goals for DCTC as well as a schedule for the initial program implementation and expansion. It also instructed the Secretary of Defense to establish methodologies and criteria for: identifying and targeting critical skills gaps, tracking program success in addressing these gaps, identifying educational institutions to participate in DCTC, selection of students (and program-associated financial support), transition of the student to a DoD employee, and identifying resources needed for the program.

programs would be leveraged to create and implement DCTC in order to increase efficiency and the likelihood of success. Specifically, the application process and criteria for DCTC would be similar to the SMART application process. Additionally, the STEM degrees eligible for DCTC participation would include the SMART program-funded disciplines as well as those relevant to the DoD's critical technology (CT) areas. Universities with existing ROTC programs would be prioritized so that the DCTC program can utilize existing infrastructure at that site. Additionally, DCTC would build a science-focused curriculum to leverage STEM knowledge and critical skills for public service within the DoD. The curriculum includes courses aligned with the DoD's requirements and addresses technological challenges and modernization priorities of the DoD. In addition to taking STEM courses and DoD-specific courses, DCTC participants would gain practical skills and experience through summer internships at DoD facilities. Following the completion of the DCTC program, participants would be hired into DoD STEM positions and be required to fulfill an incurred service commitment. These key components are intended to promote DCTC students to gain experience and expertise in applying their knowledge of emerging technologies to current and future challenges facing the DoD. As the program continues over time, there would be regular updates to the program to ensure that it addresses the most pressing needs for the DoD.

B. ROTC Program

The program is the largest single source of commissioned officers for the United States (Kamarck 2021). The ROTC program was created in 1862 and permanently established by Congress in 1916. The ROTC program is a scholarship-for-service program offered at many U.S. colleges and universities. While enrolled in ROTC, students receive full or partial tuition in exchange for 4 years of service as a military officer (but the length of time owed may depend on military specialty). There are currently 273 Army ROTC programs, 150 Navy/Marines ROTC programs, and 145 Air Force ROTC programs at a total of 478 college and university campuses. While enrolled in the ROTC program, cadets must complete coursework during the semester on subjects that will help the students develop into effective military leaders. The curriculum and volume of coursework varies between universities and between Services, but it generally focuses on critical thinking, leadership principles, decision-making, military doctrine, team development and management, military operations and tactics, weapons training, and physical readiness. Meanwhile, students participate in regular drill periods to learn basic military skills and etiquette. The cadets are educated and trained at a detachment located at the university, and in some cases, cadets from more than 1,100 additional institutions of higher learning are also able to participate by means of cross-institution agreements.

There are additional Service-specific requirements for entrance into or graduation from ROTC. For instance, all students enrolling into an ROTC program must pass a physical fitness test (the standards for this test differ by Service). There may also be additional indoctrination courses (e.g., the Navy New Student Orientation) that must be completed before a scholarship is granted. Prior to graduation, students must complete summer courses or activities that bolster their skills. Specifically, Army ROTC Cadets must pass a Basic Camp and Advanced Camp prior to graduation, and Air Force Cadets must pass a Field Training course. Navy ROTC Cadets have a number of options for summer training, including training on surface vessels, with aviation squadrons, with marine units, and on nuclear submarines. Cadets in all Services have the opportunity to participate in additional training schools, such as the Army Air Assault School or the Cadet Summer Language Immersion Program.

The long-running duration of the ROTC program allows us to view both the short- and long-term success of the program. In the short term, about 56 percent of all yearly commissioned military officers graduate through the ROTC program (CNA n.d.). The remaining 44 percent of officers are from the Service Academies, Officer Candidate School/Officer Candidate Training (OTS/OCT), or achieve this distinction through other means (e.g., direct commission). In the long term, for the Army, the promotion rate to Major (or O-4) is higher for the ROTC program than for the U.S. Military Academy (45.6 percent vs. 37.7 percent, respectively) but lower than OTS/OCT (51.3 percent) (Baglini 2021). The success of the program is also evidenced by the number of high-ranking military officers that commissioned through the ROTC program. For instance, among the current (2022) members of the Joint Chiefs of Staff, five out of the eight members are ROTC graduates (General Mark Milley, Admiral Christopher W. Grady, General David H. Berger, General Charles Q. Brown, Jr., and General John W. Raymond).

There are costs and benefits to students participating in the ROTC program. Students benefit from financial aid, a postsecondary education, and a stable career upon graduation. Students also benefit from training alongside students in their cohort that they will likely encounter during later stages of their military career. Additionally, the program offers students a chance to experience a relatively standard college experience, while attending one of the Service academies requires full-time immersion in the military lifestyle. Participating in ROTC program leads to a commitment of military Service. A student may make the decision to join an ROTC program early in their college career, and they may later decide that they do not wish to commission as an officer but must serve their incurred time regardless of repay costs. Students enrolled in an ROTC program also have additional duties beyond their degree coursework that they must complete in order to remain in good standing in the program. Thus, an ROTC program may not be desirable for students who do not wish to have additional responsibilities.

C. SMART Program

The SMART Scholarship-for-Service Program was piloted in 2005[3] and permanently established by the DoD in 2006. As indicated by its name, the goal of the SMART Program is "to provide financial assistance for education in science, mathematics, engineering, and technology skills and disciplines that, as determined by the Secretary, are critical to the national security functions of the Department of Defense and are needed in the Department of Defense workforce."[4]

The SMART Program supports the DoD's science and engineering (S&E) workforce at laboratories and facilities that choose to participate in the program.[5] These participating facilities are referred to as sponsoring facilities (SFs). The SMART Program is a scholarship-for-service program that provides scholarships (tuition plus a stipend) for students pursuing undergraduate and graduate degrees (bachelor's, master's, and doctoral degrees) across 21 different STEM disciplines. As recipients of the SMART award, scholars are required to complete summer internships at their selected SF.[6] Additionally, scholars are required to complete 1 year of paid employment within the DoD civilian workforce at their selected SF for every year they receive the scholarship. It is important to note that the SMART Program does not select scholars for the program. Instead, the program provides outreach to solicit quality applications in order for the SFs to select the best applicants to fit their anticipated workforce needs. The SFs make the final decision on who they may sponsor (i.e., award a scholarship) and subsequently hire into a full-time position at their facility.

The primary goal of the SMART Program is quoted above but an additional goal listed in Title 10, U.S. Code, Section 4093 is to "attract and retain diverse STEM talent deemed relevant to national security needs, such as the DoD Modernization areas of study." In addition to these primary goals, there are a number of additional Program goals set by the FY21 NDAA, the SMART Program Office (SPO), and two separate evaluations of the SMART Program by IDA: *SMART Outcome Evaluation Report* (Balakrishnan et al. 2018) and *Evaluation of SMART Program 2.0: Process Evaluation* (Belanich et al. 2021).

The SPO begins the awards process each year by collecting the anticipated workforce needs from the SFs. The workforce needs projections include both the required degree levels and the STEM disciplines requested by each SF. This information also drives

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3 The program was piloted in response to the FY05 NDAA. See National Defense Authorization Act for Fiscal Year 2005 Report, Committee on Armed Services, United States Senate, S. Rep. No. 108-260, at 387 (May 11, 2004), https://www.congress.gov/108/crpt/srpt260/CRPT-108srpt260.pdf.

4 10 U.S. Code § 4093. The SMART program was originally authorized in § 2192a, but was the section was renumbered in FY22

5 For a more in-depth review of the SMART Program, see Belanich et al. 2021.

6 Students who receive a SMART award are termed "scholars."

outreach efforts to solicit high-quality applications for the SMART Program, which requires considerable effort.

Once applications are received, a selection panel comprised of members from the SFs and subject matter experts conducts a preliminary review. The workforce planning projections are used in conjunction with the number of applications received in each discipline, historical trends related to the selection of scholars in the discipline, and the SMART Program budget to determine the number of applications per discipline and degree level that move onto the second review by the SFs. At this point in the selection process, the decision to select scholars rests solely on the SF; the SPO has little input into the final selection process of scholars in that it is at the SF where they will ultimately be employed. A final step before awards are finalized is a site visit by the potential scholars. In these visits, scholars visit the SF that selected him/her for the SMART award to confirm that the SF is a good fit for the scholar and to begin the clearance process in preparation for the start of the internship the following summer.

Between the site visit and the start of the service commitment, the SPO's oversight is limited to ensuring that the scholars are meeting the educational requirements for the program, including maintaining their grade point averages and ensuring that they are on track to complete their degree(s) as indicated on their award paperwork. Upon successful matriculation, the scholars begin their service commitment at their SF. This is a critical milestone for the SPO as it represents the filling of a workforce need for the DoD by the SMART Program. The hiring of the scholar as a federal employee by the SF begins the fulfilment of the service portion of the scholarship-for-service agreement.

Finally, once the scholar has completed their service commitment, they move onto the post-service commitment phase where the scholar continues working for the SF. The SPO continues to monitor scholars for 10 years via annual reports. Although the SPO is no longer intimately involved in the scholar's work, the scholar may opt to remain connected to the program by serving as a mentor for new SMART scholars or participating in alumni activities such as the annual research symposium or serving as an ambassador for the program. They may even work on behalf of their SF to conduct outreach to bring in applications to the SMART Program.

The SMART Program operates independently from the academic institutions the scholars attend, in that they do not maintain a formal relationship with the schools that provide the education/courses to the scholars. Because the SFs ultimately select which scholars receive awards, these scholars represent a large distribution of universities across the United States and its territories. For example, across the lifespan of the program (2006–2021), the 3,783 scholars receiving SMART awards represented 451 different undergraduate and graduate universities. There is an annual change in the universities from where potential scholars submit applications. This change can be expected given that the likelihood that an application is submitted can be affected by a number of factors such as targeted outreach efforts by the SMART Program, change in university advisors familiar with the Program, school/university no longer in business, etc. Accordingly, when examining the distribution of scholars, the SMART Program generally has only a few schools (eight schools between 2016–2020) that might average five or more new student awards per year, with most schools only having one or two awards in a given year and many schools not having any students receive awards consistently each year.

D. DoD STEM Workforce

One of the initial planning elements directed in the NDAA for the implementation of DCTC is "a methodology to identify and target critical skills gaps in [DoD] occupations relating to acquisition, science, engineering, or other priority occupations." The OUSD (A&S) and (P&R) implementation plan describes how DCTC will use the DoD CT areas to inform this planning element requirement. However, in order to fully identify critical skills gaps facing the DoD in the occupations of interest and to develop a basis for assessing and planning to address the DoD STEM workforce needs, the DCTC must understand the current state of the DoD workforce involved in STEM-related occupations. The DoD STEM website states that there are almost 300,000 STEM professionals in the DoD across the Services and Fourth Estate agencies (Department of Defense n.d.).[7] For additional background on the structure of the STEM workforce, see Appendix B.

The Human Capital Initiatives (HCI) Office within OUSD (A&S) compiles and analyzes key aspects of the Defense Acquisition Workforce (DAW) on a quarterly basis. Information from the HCI key information summaries produced at the end of the fourth quarter of FY21 were used to provide the following information on the composition of the DAW by all 14 functional career fields as established by HCI (HCI n.d.). A functional career field is a high-level descriptor to the type of job a person may be in. Career fields could be considered a cluster of occupations that are grouped together based on the knowledge, skills, and abilities needed. Figure 1 illustrates the number of employees in the top 10 populated functional career fields using data presented in the HCI functional career field information summaries. Half of the top 10 functional career fields are typically identified as employing personnel with STEM education: engineering; production, quality, and manufacturing; test and evaluation; information technology; and science and technology manager.

[7] DoD STEM is the office within the Office of the Under Secretary of Defense, Research and Engineering (OUSD (R&E)), charged with managing some STEM education and development programs and oversight of the DoD's broader portfolio of STEM education and development programs (https://dodstem.us/about/).

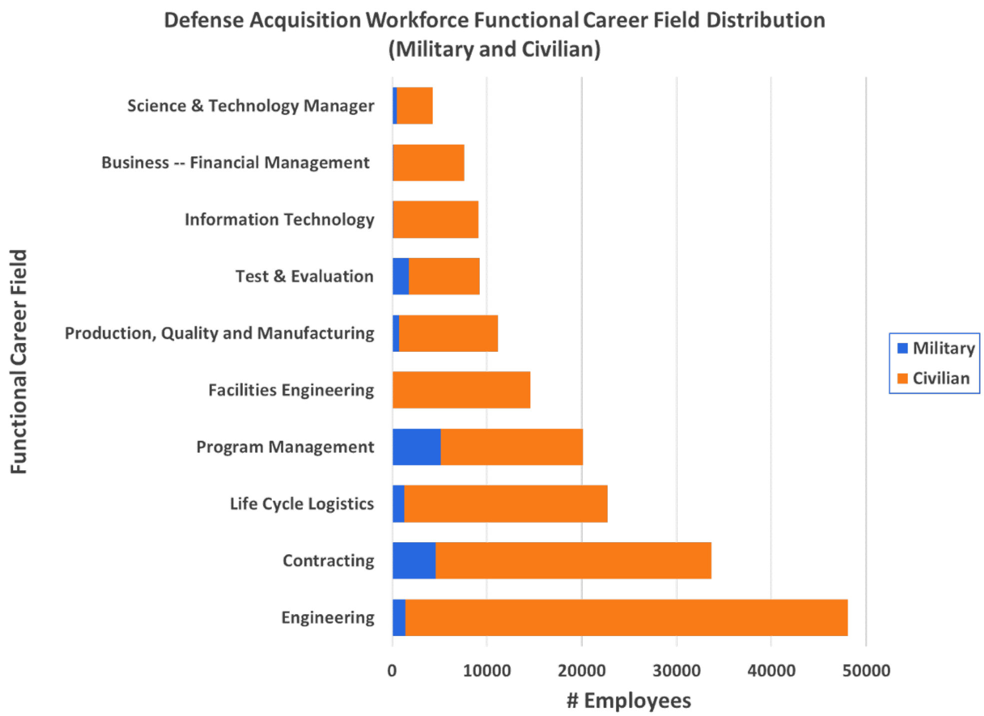

Figure 1. Number of DoD employees in the top 10 populated functional career fields.

Given the expanse and breadth of the DoD STEM workforce, it may be difficult to identify specific DoD STEM workforce needs. The DCTC program will need to develop a process to address this issue. One approach would be to solicit input from the DoD components, labs, and facilities that focus on DoD CT areas. These facilities would know their expected needs and capability to provide internship positions and employment for DCTC scholarship recipients. This is a similar approach to that used by the SMART program, described above.

E. STEM Talent Retention in the DoD

One of the primary goals for all federal scholarship-for-service programs is to provide the future workforce with opportunities to experience working for the federal government and to develop a better understanding of the organization's mission, vision, and impact in order to improve retention of the federal workforce. In 2020, the Center for Strategic and International Studies (CSIS) conducted a study to identify hiring and retention barriers for STEM civilian employees of the DoD (Sheppard et al. 2020). The study used a mixed-methods approach to qualitatively and quantitatively identify which factors disincentivize STEM professionals from taking positions within the DoD and/or which factors drive STEM employees in the DoD from their position. The study concluded that there are four main barriers to hiring and retaining STEM professionals in the DoD, as described below.

First, the report notes that "…lengthy hiring timelines and lack of transparency cause the defense enterprise to lose new STEM recruits before they are even on-boarded" ((Sheppard et al. 2020). That is, recent STEM graduates may not be willing to undergo the long on-boarding timeline if they have other job alternatives. They also may not have the financial means to wait until the on-boarding pipeline has been completed. The second barrier to retention is that DoD labs may lack support for STEM workforce concerns. According to the report, "STEM professionals may become frustrated and choose to leave federal service, oftentimes to support defense missions from elsewhere in the ecosystem" (Sheppard et al. 2020). Relatedly, another barrier is that STEM professionals often have insufficient opportunities for development and promotion, which may cause them to seek employment elsewhere. Finally, the report notes that an additional barrier to retention is a lack of career flexibility. For instance, STEM professionals lack the flexibility to further their education or to do rotations inside the private sector or academia.

The report concluded by presenting an overall take away message: "Like most professionals in the civil and armed services, technologists are motivated by a variety of factors, including mission and a drive to solve hard problems. This finding is consistent with talent management research, which concludes that 'purpose' is a key to retention. STEM professionals, therefore, will leave the defense enterprise when they lack purpose, frequently because they do not have the necessary skills, tools, and opportunities to solve tough problems in support of defense missions" (Sheppard et al. 2020).

Data from the Federal Employee Viewpoint Survey (FY21) support the findings of the CSIS study. The Federal Employee Viewpoint Survey is an annual survey administered to the federal workforce to assess the climate and culture of each major organization. The results from the government-wide workforce survey in FY21 showed that 30 percent of surveyed employees reported intention to leave their job within the next year to retire, to take another job within the federal government, or to take another job outside of the federal government (U.S. Office of Personnel Management 2021). Within the DoD, the top reason for wanting to leave a position was lack of growth potential.[8] In a follow-on item, respondents noted several factors that contributed to preventing them from reaching their full potential, including a lack of understanding of their career path and a lack of training opportunities. Of note, these results represented all DoD employees, not simply STEM professionals. As described further below, components within DCTC may address some of the shortcomings that lead to employee attrition.

F. University and College Talent Pool

The DCTC would draw from the talent pool at U.S. universities and colleges. For the initial DCTC plan described in Title 10, this would consist of students pursuing a

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[8] https://www.dcpas.osd.mil/sites/default/files/2021-OPM-FEVS-AES-DOD.xlsx

bachelor's degree. To provide some scope to the talent pool, according to the National Center for Education Statistics (NCES), in 2018–19 there were 1,980,665 bachelor's degrees conferred at U.S. postsecondary institutions, with about a quarter of those being in STEM degrees (NCES n.d.). Table 1 shows the number of degrees conferred in the general fields of study that are considered by the SMART Program and would probably be included in DCTC. This indicates that in a given year, approximately half a million bachelor's degrees are awarded to students that might possess the skills and education sought after with DCTC.

Table 1. Number of Degrees Conferred in 2018–19

Field of Study	Number
Engineering	126,687
Biological and biomedical sciences	121,191
Psychology	116,536
Computer and information sciences	88,633
Physical sciences and science technologies	31,148
Mathematics and statistics	26,146
Engineering technologies, engineering-related fields	19,089
Total	529,430

Education and training are the foundations for building the capacity of the future STEM workforce. There are a number of pathways into STEM careers, including a variety of postsecondary education options (e.g., certificates, 2- and 4-year degrees). For STEM fields, obtaining a 4-year degree is the norm such that American Community Survey reports that approximately 45 percent of the STEM workforce holds a bachelor's degree or higher while 34 percent of the non-STEM workforce hold similar degrees (U.S. Census Bureau n.d.). Further, within S&E and S&E-related occupations, a large majority hold a bachelor's degree or higher (76 percent and 60 percent, receptively) while only 12 percent of individuals in middle-skill occupations hold similar degrees. The skilled technical workforce (STW) are those who have skilled jobs that don't require a bachelor's degree, and they often hold associate's degrees from 2-year institutions. In 2019, approximately one quarter of the associate degrees awarded were in S&E or S&E technology fields and 30 percent of the STW in STEM occupations held associate's degrees.

G. Diversity in STEM

Rather than simply focusing on increasing the number of the U.S. STEM workforce, there may be additional means for improving the overall workforce. Due to the increased growth of interdisciplinary collaborations, new discoveries in STEM have leveraged the diverse perspectives, skills, and knowledge that emerge from the adoption of a "team science" perspective (National Academies of Sciences, Engineering, and Medicine 2019; National Research Council 2015). Further, both the National Academies of Science, Engineering, and Medicine (2011) and the European Commission (2003) note that diversity of the workforce is critical for addressing national priorities and promoting progress and innovation in STEM.

1. Gender

Gender diversity in STEM differs considerably by degrees pursued/conferred and by discipline. For example, the National Center for Science and Engineering Statistics (NCSES) within the National Science Foundation (NSF) statistics report that just under one-half (46–49%) of all S&E degrees were earned by women in 2019 (NCSES 2021).[9] However, it varies significantly across disciplines. For example, women received a majority of degrees in the agricultural sciences, biological sciences, and social sciences (particularly in psychology) across all degree levels in 2019. On the other hand, women earned only 20.6 percent of the bachelor's, 32.8 percent of the master's, and 22.9 percent of the doctoral degrees in computer science during the same period. Likewise, women earned 22.7 percent of the bachelor's, 26.3 percent of the master's, and 24.6 percent of the doctoral degrees in engineering. For additional details on gender diversity by degree level and STEM disciplines, see Appendix C.

2. Race and Ethnicity

Participation in STEM education across racial groups varies in S&E degree attainment levels. The National Science Board of the NSF reported that although the gap in educational attainment has narrowed over the years, the gap remains due to differences in the rates of high school completion, college enrollment, and degree completion across racial and ethnic groups. Although Hispanic individuals comprise 20 percent of the U.S. population between the ages of 20–34, they earned 16 percent of the postsecondary degrees in S&E. Likewise, Black or African American individuals make up 14 percent of the population but earned about 8 percent of the S&E degrees awarded in 2019. On the other hand, Asians (who comprise 7 percent of the population) earned 11 percent of the S&E degrees and White individuals (54 percent of the population) obtained 58 percent of the S&E degrees in 2019. For additional details on race/ethnicity diversity in STEM education, see Appendix C.

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9 NCSES classifies the following disciplines as S&E: astronomy, chemistry, physics, atmospheric sciences, earth sciences, ocean sciences, mathematics and statistics, computer sciences, agricultural sciences, biological sciences, psychology, social sciences, engineering, and medical and health sciences (at the doctoral level but not professional degrees). NSF data also references S&E occupations that include biological, agricultural, and environmental life scientists; computer and mathematical scientists; physical scientists; social scientists; and engineers, including postsecondary teachers in these fields.

The United States is a racially diverse country, and students of all races and ethnicities can be found at any university. However, there are some schools that have received a formal designation for having a student body that has a concentration of students that are racially or ethnically diverse. The designations include Minority Institutions (MI), which are institution of higher education whose enrollment of a single minority or a combination of minorities exceeds 50 percent of the total enrollment. There are also Minority Serving Institutions (MSI), which meet a threshold of their student population identifying as particular minority groups. An additional category is a Historically Black College or University (HBCU), which are schools established before 1964 whose principle mission is the education of Black Americans. There are also Tribal Colleges or Universities (TCUs), which are schools that are controlled and operated by federally recognized American Indian tribes. See Appendix D for more information on MSIs and HBCUs.

3. Improving Diversity in the Science and Engineering (S&E) Workforce

Although the STEM workforce in the United States has become more diverse over time, it still falls far below the rates of diversity of the general population (Pew Research Center, 2018). Understanding the causes and contributors to this imbalance is important as the population, particularly those who are at the age to enter the workforce, is becoming increasing diverse. As described earlier in this report, women and men have relatively similar rates of degree attainment across degree levels; however, this varies based upon both racial/ethnic group and the S&E discipline. As such, in order to improve gender diversity in recipients of S&E degrees, it is important to consider the specific disciplines of interest. For example, gender diversity efforts could focus on bringing more women into computer science programs and more men into psychology or social science programs at community colleges and universities.

Although college graduation data suggests that there has been a narrowing of the gap between racial/ethnic groups in terms of S&E degree attainment, the gap remains. In terms of under-represented minorities, Hispanic students earned a majority of associate's degrees in 2019 while Asian and Hispanic students earned the majority of bachelor's degrees. Asian, Black/African American, and Hispanic students earned the majority of master's and doctoral degrees in this period. Yet, despite these achievements, White students earned more S&E degrees across all levels (except associate's degrees) than students of all other racial/ethnic groups combined. This lack of diversity in S&E degree attainment plays a role in the lack of diversity of the S&E workforce. The National Science Board (2022) reported that Hispanics, African Americans, and other racial and ethnic minorities continue to remain under-represented in the science and technology (S&T) workforce relative to the general workforce. Likewise, the Pew Research Center (2018) determined that despite African Americans making up 11 percent of the U.S. workforce, they only make up 9 percent of the STEM workforce, and only 7 percent of this group have a bachelor's degree or higher. Similarly, Hispanics, who make up 16 percent of the workforce only make up 7 percent of the STEM workforce, of which 6 percent hold a bachelor's degree or higher. That being said, there has been a significant increase in both the rate of minority students graduating from U.S. high schools and the rate of non-traditional[10] student enrollment in higher education, so much so that it is anticipated that they will outpace traditional undergraduates within the next decade (U.S. Department of Education 2017).

[10] Non-traditional students are at least one of the following: independent (i.e., not dependent on families for support); having one or more dependents; being a single caregiver; not having received a standard high school diploma; delayed enrollment in postsecondary education by one or more years after high school; working full time while enrolled; and/or attending school part time (Brock 2010).

3. Analytic Approach

The framework and approach used by IDA to qualitatively evaluate the initial DCTC program design (i.e., Case 1 in this report) and the alternatives developed (Cases 2–5) is roughly based on a set of questions known as the "Heilmeier Questions" (or the "Heilmeier Catechism"). Developed by George Heilmeier, the former Director of the Defense Advanced Research Projects Agency (DARPA), the questions provided a framework for program managers and leadership to describe and evaluate proposed research programs. The Heilmeier Questions are listed in Table 2 (DARPA n.d.). This framework allows for decision makers to make an apples-to-apples comparison of proposed research programs in order to determine the priority and importance of these new initiatives.

Table 2. The Heilmeier Questions or Catechism

1. "What are you trying to do? Articulate your objectives using absolutely no jargon.
2. How is it done today, and what are the limits of current practice?
3. What is new in your approach and why do you think it will be successful?
4. Who cares? If you are successful, what difference will it make?
5. What are the risks?
6. How much will it cost?
7. How long will it take?
8. What are the mid-term and final "exams" to check for success?"

IDA used the framework of the Heilmeier catechism to analyze the initial DCTC program design and alternative options for implementation. The responses to the first two questions are consistent for the initial implementation plan and alternative options. In response to the first Heilmeier question regarding the intent of the DCTC program, IDA identified two main objectives for the program: 1) to build a civilian workforce that can help the United States maintain technical superiority; and 2) to bring in and retain new talent so that they can address the Department's S&T needs. However, focusing on current needs is insufficient as it may cause the DoD workforce's S&T expertise to fall behind over time if the needs change. Therefore, the DCTC program is designed to recruit individuals with cutting-edge experience and STEM knowledge to anticipate, identify, and address future gaps and be innovative in quickly integrating new technologies to solve the complex problems for the DoD.

In terms of the second Heilmeier question regarding how the issue is addressed today, new talent is usually brought into the DoD STEM and/or acquisitions workforce through traditional hiring mechanisms (i.e., USAJobs), with some of those being hired by means of a direct hiring authority granted by the Office of Personnel Management (OPM). For this process, applicants apply to positions posted on USAJobs, which notes the particular factors of the open position. However, potential applicants may not be familiar with the DoD in terms of specific organization's missions or the types of STEM-based problems they face. In addition, the applicant may not have experience working within the DoD or have an understanding of how to leverage a STEM discipline to address a DoD need. Additionally, there are a few programs that share some objectives with DCTC, such as the SMART Program described above.

For each alternative option (Cases 2–5), IDA focused on addressing the following questions in its analysis (see each option below for details):

- How does the option differ from the initial plan and the alternatives and why it may be successful?
- What are the expected outcomes?
- What are the risks?
- How much will it cost?

4. Initial Program Design and Alternative Options

In this section, we provide a more detailed description of the initial program design (Case 1) as well as four alternative options (Cases 2–5). After describing each case, we then compare the cases and discuss trade-offs and issues that would be influenced by the selection of particular cases.

A. Initial Program Design (Case 1)

Case 1 is the initial design as outlined in Title 10 and described in the OUSD (A&S) and OUSD (P&R) implementation plan. In this plan, the program would offer 4-year scholarships to students pursuing a STEM bachelor's degree at selected universities that participate in the program. After graduation, DoD facilities who have partnered with the DCTC program will hire DCTC awardees into STEM positions. As a term of the DCTC award, participants are required to fulfill a service commitment of 2 years per year of scholarship received.

Additionally, awardees would complete a DCTC curriculum prior to graduation. The proposed curriculum, described in detail in the Curriculum section later this in chapter, would include courses on the DoD mission and National Defense Strategy, DoD acculturation and public service, DoD technical challenges and emerging technologies, the Military/Civilian/Industrial team, the DoD research and development acquisitions process, and leadership and collaboration. As planned, the DCTC program would implement a number of deeper learning approaches to aid in applying the students' scientific knowledge of emerging technologies to current technical challenges facing the DoD. For example, throughout the program, students could participate in cohort team events that would require the application of material learned in courses. Further, students would complete a Capstone project prior to graduation that would tie together knowledge acquired throughout the duration of the program. Another deeper learning approach leveraged by the DCTC program would be a summer internship requirement for awardees. Through these internships, students would gain hands-on experience in both acquisition and DoD STEM workforce activities.

In order to be eligible for the DCTC program, an applicant must be a U.S. citizen and must be 18 at the time of entry into the DCTC program (or 17 with parental/guardian permission). They must pursue an undergraduate degree in an approved STEM discipline at a DCTC host college/university and must remain in good standing with the college/university while maintaining a minimum Grade Point Average of 3.0 (on a 4.0 scale). Finally, the awardee must be willing to participate in summer internships at DoD facilities, must accept post-graduation employment at a DoD facility, and must be eligible to obtain and maintain a secret security clearance. Upon graduation, DCTC scholarship-for-service awardees would enter into the DoD civilian workforce. The exact process for hiring awardees into the DoD workforce is not clear; however, the OUSD (A&S) and OUSD (P&R) implementation plan states that "The Department will utilize its non-competitive direct hire authorities, to include the Department's Post-Secondary Students and Recent Graduate authority granted under section 1106 of FY 2017 NDAA, to appoint graduates into vacant civilian positions."

Per the OUSD (A&S) and OUSD (P&R) implementation plan, the DoD will determine which accredited educational institutions can participate in the DCTC program. In its evaluation of eligible institutions, the DoD will examine the availability of STEM courses/degrees and other opportunities in fields that strongly associate with the DoD modernization priorities as well as the availability of STEM courses/degrees (e.g., the 21 SMART Program-relevant disciplines) and the availability of student opportunities to apply STEM skills. The DoD will also consider the institution's geographical proximity to DoD labs and acquisition and/or other organizations as well as existing long-term supportive partnerships with those locations. Because the DCTC program is designed to leverage the strengths of the ROTC program, the DoD will consider an institution's support of ROTC students and willingness to establish a partnership through a resulting contract similar to ROTC contracts with institutions. Finally, the DoD will examine the institution's infrastructure, resource, and program needs in identifying partnering institutions for the DCTC program.

Title 10 and the NDAA both note that the full implementation of the DCTC program will include at least 20 accredited educational institutions with at least 400 awardees at these institutions. The OUSD (A&S) and OUSD (P&R) implementation plan provides greater detail on the graduated expansion of the DCTC program. For example, during the first year, the program would award 20 scholarships to students across 5 participating educational institutions. During the second year, the program would expand to include 12 institutions and include 20 students/year for each institution. During the third year, the program would expand to 20 institutions with 20 students/year for each institution. At full implementation, 1,600 students will be enrolled in the DCTC program at any one time with 400 students graduating and entering the DoD STEM civilian workforce each year.

B. Alternative Implementation Options

The alternative cases vary along a few dimensions (e.g., length in scholarship, cost, degree level, post-graduation training), as depicted in Figure 2. In summary, Case 1 is a 4-year scholarship for service program with an extended service commitment post-graduation. Case 2 engages students after they have already completed 2 years of their bachelor's degree so the scholarship and service commitment time periods are reduced. Case 2 also includes the potential for some awardees to work towards a master's degree (incurring an additional service commitment). Case 3 focuses on the STW, and engages students working towards an associate's degree or technical certificates. Case 4 focuses on summer internships, and does not include a scholarship so it also does not require a post-graduation service commitment, though it would facilitate the hiring of successful participants. Case 5 is designed to leverage other existing DoD STEM-related programs, but includes the DCTC curriculum that would also be used in Cases 1–5.

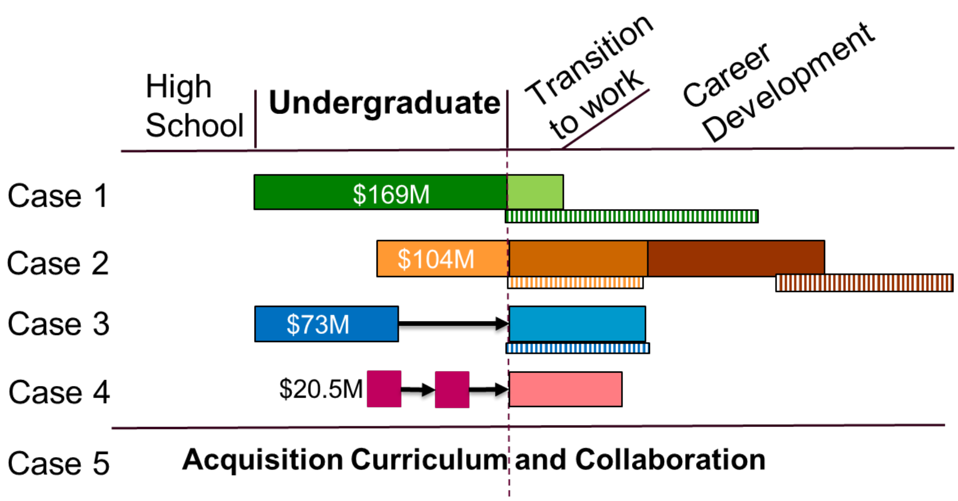

Figure 2. Graphic depiction of the cases in relation to one another. The thicker, darker shaded bars during the undergraduate span indicate the general time that participants are engaged in the program, and potentially drawing a stipend and/or paycheck for an internship. The lighter shaded bars indicate a transition to work period when people are on-boarded and developed post-graduation. The thinner stripped bars indicate a service commitment incurred from the scholarship.

While the cases may differ, IDA used some consistent assumptions across all options. For example, in terms of program cost, IDA estimated the cost with the assumption that 400 students would graduate from their academic institutions and the DCTC program and enter the DoD civilian workforce each year. This assumption affected program costs for the alternative options. For example, one alternative Case provided scholarships-for-service only for the last 2 years of undergraduate degree pursuit. In this case, reducing the scholarship period from 4 years to 2 years clearly leads to a reduction in program costs. Additionally, some of the alternative Cases do not provide a scholarship (e.g., an internship-only option) and therefore would not have an associated service commitment. Thus, these awardees would not be required to join the DoD workforce after their participation in the DCTC program, but would be encouraged to join. Each alternative option includes a DCTC course curriculum; however, the duration and number of courses may vary across options. Finally, the alternative options include programs to aid in the initial transition to work and/or continuing career development for program participants. As such, the DCTC program will collaborate with awardees' institutions to facilitate leadership and acquisition training, which may allow for the maintenance of a long-term relationship with the DCTC network, organization, and fellow awardees. We provide additional details regarding these assumptions as well as case specifics below.

1. Case 2 – 2-Year Scholarship

Similar to the original concept of the DCTC program (Case 1), the goal of Case 2 is to provide the DoD an infusion of civilian technical expertise, innovation, and acquisition experience in modernization priority areas through the development of a network of new acquisition professionals. In addition, this option includes program support for the growth and retention of DCTC awardees in order to maintain technical superiority within the acquisition workforce.

Case 2 is an alternative program that is unique from Case 1 in two ways. First, in Case 2, students pursuing STEM bachelor's degrees would enter the program after completing their first 2 years of school rather than enrolling in the program prior to their first year (i.e., enrolling while still in high school without any college performance to be considered in the application). Second, there would be additional facilitation that would occur during the transition to the workforce, with additional career development efforts that could promote longer-term retention. This ongoing career development might be additional training or possibly a master's degree option that would incur additional service commitment. Like Case 1, there would be both DCTC curriculum and summer internships, but these would be only during the junior and senior years of college. The initial service commitment would be shorter than the one incurred in Case 1 (4 years vs. 8 years).

Recruiting students who have completed 2 years would allow the students time to determine if a STEM degree best fits their interests, and if so, which STEM discipline to pursue. The justification of focusing on the final 2 years of an undergraduate degree is based on a finding by the U.S. Department of Education (2017) that states that for students in STEM fields (i.e., computer and information sciences, and engineering and engineering technology) approximately a third change majors within 3 years of enrollment. Further, by delaying the start of the DCTC eligibility, the program has access to applicant data from their postsecondary education (versus data from only secondary school) in order to use in the assessment and selection of awardees.

In addition to the 2-year scholarships, awardees would be required to participate in summer internships during these 2 years. They would also be required to take DCTC curriculum classes. Through these DCTC curriculum and internship experiences, Case 2 would increase the awardees' knowledge of public service and the role of the acquisition workforce within the DoD. Case 2 could include opportunities for cohorts (e.g., DCTC participants at the same university/college) to complete a Capstone project at the end of each academic year, become familiar with DoD acquisitions via courses as part of a degree program, and gain hands-on experience in both acquisition and DoD STEM workforce activities. In addition, this program would facilitate early career development focused on leadership and on continued professional development for participants.

Once the awardee has received their bachelor's degree, they would be hired by one of the DoD organizations providing DCTC summer internships (or could be limited to one of the DoD organizations at which the participant served an internship). The hiring organization and the awardee, with support from the DCTC program, would commit to the participant completing a minimum of at least one leadership course approved by DCTC and one acquisition workforce training course per year for the first 2 years (length of commitment) that will be applied towards earning a Defense Acquisitions University (DAU) acquisition certificate or credential. In addition, DCTC can provide opportunities and ways for DCTC awardees to maintain connection with the network of DCTC scholars and organizations such as by establishing a DCTC social network site and hosting regional meetings for DCTC scholars and organizations (universities/DoD component organizations).

Further, after employment, interested DCTC awardees can apply for continued professional development through pursuit of a graduate degree funded by the DCTC program. DCTC master's degree scholarship awardees would be required to complete an additional 2-year service agreement for this award. Additionally, as a part of the master's degree scholarship option, the DCTC graduate awardee would be required to complete DCTC-designated leadership and acquisition workforce training courses.

IDA considered variations to Case 2 that offer additional implementation options. For example, instead of offering the option of a master's degree scholarship, DCTC could instead continue to support early-to-mid career development acquisitions, leadership, education, and training in addition to continued interaction with DCTC community. Another option is to include a smaller option for students in their first 2 years of undergraduate degree pursuit. For instance, DCTC could offer small monetary scholarships (e.g., $2,000) to individuals to participate in a program at their educational institution. This early education program might consist of two monthly meetings. One of these meetings could be informal, focused on building social networks through a fun challenge problem/team building activity. The second meeting could be more of a formal event consisting of presentations to expose the participants to more detail on public service and DoD background and opportunities. These types of smaller awards and meetings would raise awareness of public service and DoD opportunities while beginning to establish a community/cohort. An option to these early education awards would be to give such awardees priority consideration for Case 2 DCTC awards (i.e., full scholarships for service).

According to an NCES report on attrition rates in STEM and non-STEM fields, there is a significant likelihood that they may switch majors (Chen 2013). Of the students that began STEM degrees, 48 percent of bachelor's degree students and 69 percent of associate degree students left these fields prior to graduating. About a half of those leaving STEM degree fields switched to a non-STEM major, while the other half exited college before earning a degree. Students in non-STEM fields switched majors and/or exited college at a similar rate. Students were more likely to switch from a STEM degree to a non-STEM degree if they took more intense STEM coursework during their first year (particularly math), if they performed poorly in STEM courses during their first year, if they were female (for associate degree students only), or if they had a low-income background. Students with STEM majors were more likely to exit college if they had an overall lower grade point average or if they had a higher rate of withdrawn/failed STEM courses. Bachelor's degree STEM majors at public universities were more likely to switch to non-STEM majors than students in private institutions, and STEM majors that attended non-selective universities were more likely to exit college than STEM majors at selective universities.

2. Case 3 – Skilled Technical Workforce

There are many technical professions where entry into that profession does not require a bachelor's degree; however, a vast majority of DoD scholarship programs require awardees to pursue bachelor's degree at a minimum to qualify for an award. The DoD does not currently have a program dedicated to recruiting and retaining individuals who are part of the STW. As such, Case 3 is an alternative program that focuses on these professions by addressing gaps in the future STW rather than gaps in the bachelor's-level STEM professional workforce. This alternative program targets students that are earning their associate's degree or professional certifications at community or junior colleges or at 2-year institutions in fields such as cybersecurity, computer technician, and advanced manufacturing. Similar to Case 1, this alternative includes both a DCTC curriculum and summer internship opportunities. Additionally, the service commitment associated with Case 3 would also be shorter than the one incurred in Case 1.

Case 3 would also include additional support to transition from degree pursuit to the DoD workforce. It also includes career development efforts that may promote longer-term retention such as scholarship support to pursue a bachelor's degree, an additional benefit that would incur an additional service commitment. Another potential variation to Case 3 is support for non-degree certificates such as Microsoft Certified Solutions Expert (MSSE), Cisco Certified Network Professional (CCNP), and Amazon Web Services (AWS) Certified Cloud Practitioner.

3. Case 4 – Summer Internships

Case 4 is an alternative program that focuses on summer internships without a scholarship component, therefore there is no service commitment; this case would be significantly less expensive than Cases 1–3. Many undergraduate students strive to participate in internships in order to acquire skills that potential employers seek such that they gain valuable experience while also earning a paycheck. The internship-only Case 4 is also an opportunity for the DoD to acquire diverse, new STEM talent via summer internships providing hands-on experience in both DoD STEM and acquisition efforts through realistic job previews and an understanding of the DoD mission. The DCTC Case 4 option also provides students the opportunity to intern at different facilities, increasing their exposure to DoD employment opportunities and improving their understanding of public service within the DoD workforce. In essence, Case 4 can serve as an extended interview for both the student and the hiring DoD facility. Case 4 expands upon the Defense College Acquisition Internship Program (DCAIP) and existing DoD STEM internship programs to include a focus on acquisitions and diversity of new talent.

The Case 4 internships would be open to undergraduate students in STEM disciplines at accredited universities with at least 2 years remaining to complete a 4-year degree. Students selected to participate in Case 4 would receive components of the DCTC curriculum during the internships and would not have additional coursework or training requirements during the academic semester. Students participating in summer internships through DCTC may receive preferred hiring by the internship facility immediately upon graduation, as Case 4 does not carry a scholarship/commitment component. Additional training, including leadership and acquisitions training, would occur after the transition to the workforce.

The variations to Case 4 include opportunities for internship cohorts at each facility (or across facilities) to contribute to a Capstone project at the end of each internship. Another variation could be to offer hiring bonuses (e.g., step increases, financial bonus at hiring) to interns who successfully completed a DCTC acquisitions credentials program prior to hiring. Other variations include offering a small scholarship in addition to the internship, offering student loan repayment options, and even offering the internship opportunity to students who have completed at least 1 year of their undergraduate studies. From a programmatic standpoint, the option to focus on the internships is an opportunity to reach a large number of students while maintaining a relatively small budget.

4. Case 5 – Acquisition Curriculum and Collaboration

Case 5 is an option whereby DCTC can leverage existing scholarship or internship programs to include DCTC features. The DCTC curriculum could be utilized during an existing internship program in order to enhance readiness for employment in the DoD. For example, DCTC could provide the curriculum component to the SMART Program (or other scholarship-for-service or internship program) in order to facilitate a SMART scholar's understanding of the DoD and its modernization capabilities. As such, undergraduate students eligible for applicable DoD STEM opportunities (e.g., SMART, DoD College Acquisition Internship Program) would be eligible to apply and would be held to the terms of service of the opportunity (i.e., if associated with the SMART Program, awardees would be held to SMART's scholarship-for-service terms).

The program structure would depend on which specific pre-existing programs are leveraged. Alternatively, Case 5 could leverage DoD-sponsored research at universities to aid in strengthening the STEM pipeline with graduating students. For example, DCTC Case 5 could provide additional funding to primary investigators on DoD grants to provide financial support for student researchers (e.g., research assistants). Additionally, DCTC could both financially support the student researchers on existing DoD grants and provide these students with summer internship opportunities at the DoD laboratory or organization funding the research. Other variations for DCTC's Case 5 include:

- Enhancing existing programs by providing DAU-developed acquisition curriculum/training/certificate to be offered by existing programs or organizations.
- Providing cost-sharing with DoD organization for new summer internship position at DoD facilities for members of DoD STEM student chapters.
- Providing DoD STEM employees a mentor bonus for both completing some specified DAU-developed training and mentoring interns.
- Provide content and other resources (speakers, tours, etc.) to STEM-related student chapters at universities to facilitate interaction of students/faculty/DoD STEM talent.

C. Risks for Each Alternative

There are a number of risks that are shared between DCTC cases. These risks include attrition (e.g., students may change to non-STEM majors after joining the program) and the inability to attract strong candidates to the program. The magnitude of the risks differs for each case. The risk considered to be the greatest for each specific case is outlined below.

A strong risk for Case 1 is that a considerable percentage of students change majors in the first 2 years of college. According to the U.S. Department of Education (2017) about a third of bachelor degree seeking students change their majors within 3 years of initial enrollment in college (U.S. Department of Education, NCES 2017). Consequently, there is the risk that students enrolled in the DCTC program during the first 2 years of college will switch to non-STEM majors and therefore will be ineligible to continue in the program. This poses not only a risk to the objective of bringing in new STEM talent to the DoD workforce, but this also poses a significant risk to the potential DCTC awardee as well. Students may feel like they are unable to change majors due to the commitment requirement (or the requirement to pay back the scholarship if unable to complete the service portion of the award). This may result in fewer applicants for the award, large attrition issues for the program, smaller cohorts, and fewer prospective DoD employees upon graduation.

Case 2 has a lower risk of attrition due to students changing majors because it recruits candidates going into their third year of college. However, a strong risk for Case 2 is that students may not perceive 2 years of scholarship to be worthwhile in exchange for a service commitment. Additionally, students may have already planned their career in another field by the end of their second year in college such that it may be difficult to attract them to a career in public service. These students may opt for working in industry in the emerging technology area instead of working for the DoD. This risk may be exacerbated by less cohort bonding and less professional network development than would be accomplished in a 4-year program.

A significant risk for Case 3 would be not attracting strong candidates to fill DoD STEM needs to advance the DoD's CT areas. Recruiting from 2-year educational institutions would provide additional personnel for the STW, but not the bachelor's level STEM workforce. Although there is a need to recruit more individuals for the STW, the goal of the DCTC program is to attract candidates that can address workforce needs pertaining to cutting-edge STEM topics at a higher level. Depending on the needs of the DoD STEM workforce, focusing a scholarship program on developing and recruiting from 2-year programs may not be adequate as the workforce gap consists of STEM professionals across all degree levels.

Although Case 4 allows for the opportunity to reach a large number of students while maintaining a relatively small budget, a risk with this option is that it may not provide the same infusion of new talent without a service commitment requirement. This case provides summer internships and an option—not an obligation—for employment in a DoD facility. Further, Case 4 puts a heavy burden on the internships alone to draw in new STEM talent. Relative to participants in other Cases, participants in this version of the DCTC program may be more likely to pursue positions in another industry rather than pursuing government service.

The risks associated with Case 5 would depend on which existing programs are leveraged. This Case may be lower in risk than the other proposed Cases because existing programs with known risks are being leveraged, but it also may have additional risk because it is not a strong deviation from the status quo.

D. Costs for Each Alternative

In order to determine the cost of each potential program, the HCI cost model estimates developed for the initial implementation plan (Case 1) were used. We costed all options with the expectation that 400 students would graduate and enter the DoD workforce in a given year. The calculated cost estimates include tuition, university detachment costs, the establishment of a DCTC headquarters, travel, etc. For Cases 1–2, this also includes program costs at the 20 selected universities (i.e., Unit Costs) that would include items such as salaries for unit staff, tenant costs to the university for office/class space, and travel. The cost for each of the cases is displayed in Table 3.

Table 3. Cost Estimates for Cases 1–4

Case	Total ($)	Unit Cost ($)	Student Costs ($)	HQ Costs ($)
1	168,960,000	36,940,000	123,520,000	8,500,000
2	104,410,000	31,450,000	64,460,000	8,500,000
3	72,660,000	0	64,460,000	8,500,000
4	20,500,000	0	12,000,000	8,500,000

The cost of Case 5 is not listed, as the total cost would depend on which existing programs are leveraged. There are clear cost differences depending on the details of the case selected. For instance, in Case 1, 4 years of scholarship would be costlier than 2 years of scholarship (400 x 4 years = 1,600 students vs. 400 x 2 years = 800 students) that would be included in Cases 2–3. The student costs for Case 4 represent the internship stipends paid to students for their time during the summer; this cost is also incorporated into Cases 1–3. The costs decrease from Case 1 through Case 4 as features are reduced or eliminated in those subsequent cases.

The costs represented above are the costs for a fully functioning program, but there would be reduced annual costs as the programs ramped up to their final level. Such ramp-up costs would be spread out across several years based on the initial rate of program growth. Before starting the program, it would be prudent to have the ramp-up costs over the first few years and the fully functioning program level of funding stated in the Presidential Budget Request to Congress. A program like DCTC needs relatively consistent or reliable funding over years because there is a year-to-year expectancy of continuing costs that are not easily modified significantly from one year to the next. For example, if a 4-year scholarship is being offered, there is the expectation that after it is awarded in the first year it will be continued for the subsequent 3 years. In this example with 4-year scholarships, if the program funding was unexpectedly reduced by 25 percent it would basically mean that no new scholarships could be awarded that year since the program would need to first fund the scholarships from the prior 3 years of awards. This was evident in the budget sequestration adjustments in 2012, where the SMART Program's budget was reduced about 10 percent, which led to a near 50 percent reduction in new scholarships.[11]

E. Curriculum

IDA received a list of courses that could be included in the DCTC curriculum, then further developed the courses to include some additional content of each course, as described below. The scope of depth will vary proportional to the alternative timeframe. For example, with Case 1, each course might be the equivalent of a three-credit college course and DCTC scholars would take one course every semester they are in the program. For Case 2, the curriculum may be condensed so that it could be covered in the final 2 years of a student's bachelor's degree. That may require the combining of the 100-, 200-, 300-, and 400-level courses into single courses each of the final four semesters towards a bachelor's degree. For Case 3, some of the courses may be provided to students while they work towards their associate's degree and some during their transition-to-work phase post-graduation. For Case 4, the curriculum might be heavily condensed to fit into two 1-week distributed classes after each of the DCTC awardee's internship sessions and also during their transition-to-work phase if they accept a job with the DoD. For Case 5, the above options could be applied based on the circumstances of the existing programs that are leveraged for DCTC.

Courses:

Course 1: DCTC 101 – DoD Mission and National Defense Strategy; DoD/Military Departments Acculturation/Public Service. This course will describe the organization of the DoD. It will present the current National Defense Strategy and will facilitate a discussion on how current events influence the National Defense Strategy. This course will present the basics of the military structure, including the description of ranks and key military occupational specialties. The total workforce—comprising DoD civilians, contractors, and military personnel—will be described. Students will be presented with DoD civilian core values and will learn about the ethics of public service and maintaining public trust.

Course 2: DCTC 102 – DoD framework for meeting technical challenges. This course will present a framework describing past, current, and future DoD technical challenges and will present courses of action for solving these technical challenges. Case examples of how the DoD has met past technical challenges will be presented and discussed. There will be a special emphasis on developing technology that will maintain overmatch.

[11] See Figure 20 in Belanich et al. (2021).

Course 3: DCTC 201 – DoD technical challenges and emerging technologies. This course will present and describe the current DoD modernization priorities. The course will explain why the modernization priorities are important and how they change based on the international military climate. This course will specifically focus on the "science" reason why they are priorities. Students will be presented with case studies of innovation in the DoD and will discuss how previous research efforts have focused on the modernization priorities.

Course 4: DCTC 202 – Military/Civilian/Industry team – equipping the warfighter. This course will describe who the warfighter is (Army, Navy, Air Force, Marines, Space Force, Coast Guard) and the technological needs of each Service. Students will learn the respective role of each member of the DoD technological workforce team—military Service members, DoD civilians, and industry members. Students will review case studies focusing on instances during which the technological workforce team successfully accomplished goals related to DoD technical challenges and/or modernization priorities.

Course 5: DCTC 301 – Application of STEM skills to technical challenges. This course will discuss the application of basic research methodology to solving DoD technical challenges. Case studies of successful DoD scientific advances (including those conducted by Nobel Prize winners) will be discussed. Case studies will span from basic research to implementation. The organization of the scientific labs within each Service and other relevant science centers (e.g., DARPA) will be discussed.

Couse 6: DCTC 302 – DoD research and development, acquisition, sustainment. This course will discuss the basics of the acquisitions and sustainment lifecycle. Students will learn about Technology Readiness Levels and Knowledge Readiness Levels (TRL and KRL 1–3, 4–6, 7–9) and how these interplay with the acquisitions process. Students will learn about how requirements for the warfighter are developed and validated. An overview on foreign technology assessments will be presented.

Course 7: DCTC 402 – Team science, collaboration, and leading teams. This course will teach the foundational principles of leadership and collaboration. Students will learn how to support teammates and colleagues and will learn how to stay resilient in the face of stressors. Students will be presented with case studies of successful DoD scientific teams at work (e.g., the Manhattan Project). Course material on leadership will be similar to what is presented to ROTC cadets.

Course 8: Capstone DCTC 401 – Application of STEM skills to DoD challenges. This course will be an opportunity for students to apply knowledge that they learned in Courses 1–7. Students will complete a capstone project that aims to "solve" a DoD technical challenge. The project will include a feasible plan for applying basic scientific skills to DoD technological challenges and/or modernization priorities while accounting for the military/DoD civilian/industry team and the acquisitions lifecycle.

F. Trade-offs in the Implementation of the DCTC Alternative Options

There is no clear optimal case, but instead a set of trade-off issues. Depending on the relative value of these issues, it may influence the attractiveness of particular cases. Some of these relevant trade-off issues include:

- **Curriculum** – The DCTC curriculum to educate participants about the DoD and its efforts towards addressing CT areas is a feature that would be unique to DCTC. It would introduce scholars to the DoD's S&E programs and key aspects of DoD innovation, and provide practical experience and case studies of how the DoD can/will address CT areas. We are not aware of any other scholarship/internship programs that include such training. This feature is included in every case, but highlighted in Case 5.
- **DoD Work** – Internships provide a realistic job preview for students and allow the DoD to gain an extended understanding of interns. Cases 1–3 include DoD work experience as part of a larger program, while Case 4 consists mainly of the internship.
- **Under-represented** – All Cases have the option to concentrate on under-represented groups. School selection could be used to facilitate reaching under-represented groups for Cases 1–3, while targeted outreach and applicant selection can be used for all Cases. Additionally, Case 3 emphases the STW that tends to have a high representation of those traditionally under-represented in STEM.
- **Cost** – Much of the cost is from scholarships, stipends, and administrative costs. Costs decrease in order from Case 1 to 5.
- **Service Commitment** – Length of commitment decreases in order for Cases 1–3, and isn't part of Cases 4 and 5. The value/cost of a commitment varies based on external factors. When unemployment is high and first jobs after school are hard to find, the guaranteed job could be considered a benefit to awardees. Conversely, when there are many lucrative options outside of the DoD, the service commitment may dissuade some applicants.
- **Cohorts** – Participant cohort development facilitates building professional networks. This feature is most prevalent in Cases 1 and 2 where they would attend select (20) schools. However, a distributed DCTC network could be established that might enable the development of cohorts in Cases 3–5. The inclusion of a capstone project in the curriculum where students work in teams could help establish networks (cohorts).

G. Measures to Monitor Progress for Selected Alternative(s)

The success and growth of any program depends on feedback and continuous improvement. Useful metrics to assess the DCTC program success will include feedback from the DCTC participants, the DoD facilities that employ them post-graduation, DCTC coordinators, and DoD leadership. Monitoring the program will allow the program to adapt to changing needs and work towards continued improvement.

1. Continued Need

There should be a periodic assessment of DoD needs to determine how the program may need to shift over time. This needs analysis can be linked to DoD priorities in S&E along with workforce needs for particular skills sets. This helps set the goals and objectives of the programs. The CT challenges of today may be solved and new technologies may be sought in the future. Regular assessment of technology development goals will assure that DCTC is linked to S&E goals valuable to the DoD. Also, the skill sets needed by the future workforce will change overtime. Assessing the skills and competencies needed will be useful for selecting the right students as well as shaping their training and education so as to optimize the DoD's value in their investment in these students.

2. Progression of Participants

Tracking how students progress through the program would be useful to ensure the program is producing the intended outcomes. This set of metrics would include the number of students applying for the program versus awards (selectivity), the number of awardees who progress through to graduation, the number who take DoD positions after graduation, and longer-term retention. Additionally, over time it would be useful to track DCTC alumni as they advance within the DoD S&E workforce. For example, do they have a higher tendency to be promoted to leadership positions versus those hired through the standard methods or at DCTC alumni, or are they more likely to be responsible for significant discoveries and advancements in CT areas?

H. Selection Consideration of DCTC Universities

For Cases 1–2, a partnership with universities would need to be established to enable the DCTC units to engage in campus activities. U.S. Code, Title 10, Section 2200 outlines how the program should be established in at least 20 schools upon full implementation. This section covers some considerations for selecting universities for DCTC units, which could be completed in more depth after the program design has been determined.

1. Criteria Options

The intent of DCTC is to develop a workforce that is modern, agile, information advantaged, motivated, diverse, and highly skilled that can work on the DoD's most pressing needs, like the CT areas. To do this, there are some university characteristics that may be considered when selecting schools. These criteria may include: having a strong DoD research capability, an existing ROTC program, and be in relative proximity (within 150 miles) to a DoD facility or center that might provide internship locations or hire DCTC graduates, as shown in Figure 3. Additionally, there may be some other school characteristics that could play a part in identifying an appropriate set of schools, like if the school has been designated as an HBCU or an MSI, and the type of domain accreditation the school has (e.g., Accreditation Board for Engineering and Technology (ABET)).

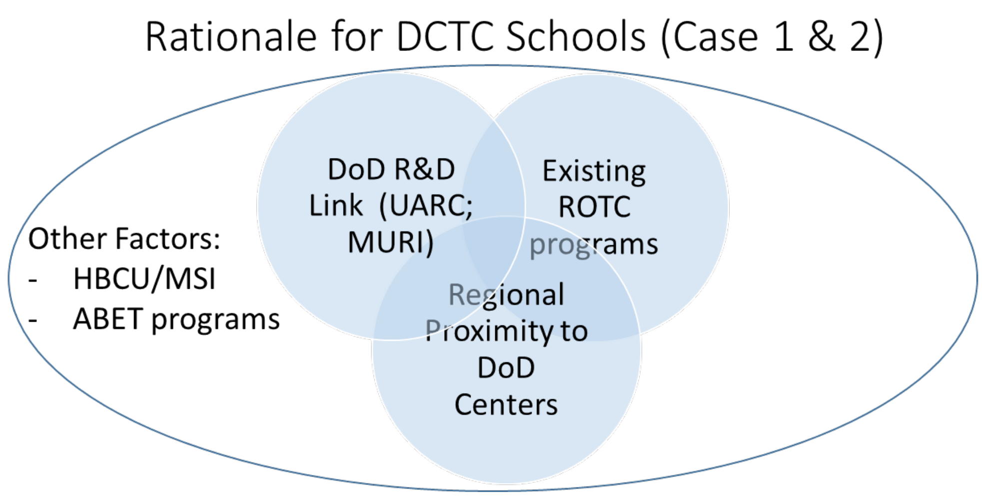

Figure 3. Graphic depiction of factors that might be considerations for selecting DCTC university sites.

2. Summary of Candidate Schools

IDA conducted a preliminary review of U.S. universities to identify a set of candidate schools that have some of the factors described above. Appendix E provides more details on the criteria for 40 schools that have a mix of strong research links with the DoD in some of the CT areas, with some of those being HBCU/MSI designated schools with an ROTC program or a University Affiliated Research Center (UARC). In addition, we list the state of the school along with the federal region used by the U.S. Department of Labor.

A cursory review of schools conducting research in the CT areas found many schools that are working in several CTs and also have additional characteristics that may make them potential DCTC sites. For example, the University of Maryland is conducting research in 8 CTs and also has a UARC. Likewise, John Hopkins (6 CTs), the MIT (6 CTs), Penn State (6 CTs), all of which also have a UARC and host ROTC programs. Purdue conducts research in 7 CTs and has an ROTC program, as does University of Michigan (6 CTs) and University of Virginia (6 CTs). Some schools like Texas A&M (4 CTs), University of Central Florida (4 CTs), University of Texas at San Antonio (4 CTs), and

University of Washington-Seattle (4 CTs) are designated as MSIs. Two HBCUs, Florida A&M and North Carolina A&T, also have ROTC programs, have ABET accreditation for several of their engineering programs, and could be considered as candidate schools for DCTC sites.

The set of schools identified here are a preliminary list of schools that could be contacted to determine their potential interest in hosting a DCTC unit. Based on a school's interest in participating in the program, additional schools could be contacted to develop a final set of 20 that span the United States. Finding the right balance of schools with the appropriate set of characteristics and willingness to be a motivated partner with the DoD, will require further analysis and engaging with the schools to determine their interest and resources they offer.

5. Summary and Conclusion

The initial DCTC implementation plan produced in August 2020 outlined how the program would be aligned with the National Defense Strategy, described the scholarship-for-service requirements, listed courses for a 4-year curriculum, and determined the initial technical areas of study. This report includes some additional details for the initial plan (Case 1) as well as descriptions of four alternative options that vary in participant duration, cost, and degree level attained, and focus on internships and the DCTC curriculum to develop knowledgeable and motivated new hires working for the DoD to address CT challenges.

A. Case Summaries

Case 1 is a 4-year scholarship-for-service program where students complete a summer internship each year, take DCTC courses during the semesters at schools with a DCTC unit, and commit to work for the DoD after graduation. Includes a long period (compared to the other cases) of development at a university with their cohort, completing projects together and learning about how they can help DoD address CT challenges.

Case 2 is a 2-year scholarship-for-service program where students complete a summer internship each year, take DCTC courses during the semesters at schools with a DCTC unit, and commit to work for the DoD after graduation. Case 2 is shorter than Case 1, which would save money and may reduce program attrition since students have already assimilated to college and their intended STEM degree plans, but has less total time for student development in their DCTC units and a shorter service commitment period. Added to Case 2 that is not in Case 1 is the opportunity for continued development after graduation with an option where some students might seek a graduate degree.

Case 3 focuses on the STW (i.e., technical positions that do not require a bachelor's degree), a segment of the STEM workforce that does not receive as much attention or support for education as those working towards bachelor's or graduate degrees. Case 3 is a 2-year scholarship-for-service program for students at community colleges (or trade schools or certificate programs) who will complete a summer internship each year, take DCTC courses during the semesters, and commit to work for the DoD after graduation.

Case 4 focuses on the summer internships component of DCTC and also includes an abbreviated DCTC curriculum. The internships provide participants with real job experience to learn and work at DoD facilities, which may motivate them to join the DoD post-graduation in that they would not be required to work for the Department since they are not receiving a scholarship (a cost savings).

Case 5 is designed as a simplified program leveraging pre-existing programs, in which the DCTC curriculum is provided to other DoD programs (high school, community college, and undergraduate colleges) for use. The duration of the curriculum could be adjusted to fit into the leveraged program. The DoD already has several scholarship and internship programs, but none of those programs has a component like the DCTC curriculum. This case would add value to those existing programs.

B. Conclusion

With the authorization of DCTC, the DoD has an opportunity to create a unique workforce program that can bring in additional talent to the DoD to address critical technology challenges. DCTC as described in the initial implementation plan has several features intended to enable the program to both attract and develop students so that they may become valuable DoD personnel ready to take on critical technology challenges. For example, the most prominent of these features is the scholarship-for-service program where it may be attractive to students to have their tuition paid and earn a stipend; however, those scholarships come with a significant cost to the government, and the value/cost of a service commitment to a student may vary based on external factors like the job market. Therefore, it is useful to consider alternative design plans as described in this report.

There is no clear best design for the program, with each of the cases having its particular trade-offs. It is also important to consider what is currently available for the DoD to bring in talent to address CT challenges. There is the current standard hiring practice through USAJobs, which may also include the use of direct hiring authorities to facilitate the process as well as some workforce recruitment programs that offer scholarships and/or internships. DCTC can be designed to bring new capabilities for attracting and training an innovative workforce, like the DCTC curriculum. Another consideration for program design is for the program to adapt as conditions change. For example, the CT challenges of today may not be those of the future, and the future workforce may require different skills and capabilities. That is why it would be valuable for DCTC to remain agile and flexible. To address changing conditions, DCTC should conduct periodic workforce needs assessments to target the appropriate workforce and refine the DCTC curriculum to maintain a relevancy towards solving the DoD’s most critical issues of the time.

Appendix A.
Initial DCTC Implementation Plan

This appendix is the initial DCTC Implementation Plan developed by OUSD (A&S) and OUSD (P&R) in August 2020.

Strategic and Congressional Action

The Under Secretary of Defense for Acquisition and Sustainment, the Honorable Ellen Lord, highlighted to Congress in March 2019 the initiative of establishing a civilian technical corps, a Science, Mathematics and Research for Transformation (SMART) Corps, as part of strengthening the technical pipeline of talent for the Department of Defense (DoD). Congress, through section 860 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020 (Public Law 116-92), established in title 10, Chapter 113, the Defense Civilian Training Corps (DCTC). Chapter 113, section 2200g, directs the Secretary of Defense (SECDEF) establish and maintain a Defense Civilian Training Corps (DCTC) program, organized into one or more units, at any accredited civilian educational institution authorized to grant baccalaureate degrees. The purpose of the program is to establish a civilian training corps to prepare selected students for public service in Department of Defense (DoD) occupations relating to acquisition, science, engineering, or other civilian occupations determined by the Secretary of Defense, and to target critical skill gaps. Section 2200g of title 10 requires DCTC implementation in three steps. The first DCTC unit must be deployed by August 2021, five units must be deployed by August 2022, and 20 units must be deployed by 2023. Additionally, the Consolidated Appropriations Act for FY 2020 (Public Law 116-93) provided funding to implement the DCTC program. Both require plans. This plan satisfies both reporting requirements.

Alignment and Support

The congressional direction establishing and providing funding for DCTC will strengthen the DoD civilian workforce and enable DoD's improved support of the White House's National Science and Technology Council's (NSTC) Science, Technology, Engineering and Mathematics (STEM) strategic goals and the 2018 National Defense Strategy (NDS) of increased lethality and readiness, expanded partnerships and technical and reform modernization objectives.

The NSTC strategic STEM goals includes "Preparing the STEM Workforce for the Future" through creating a diverse talent pool of Americans with strong STEM knowledge and skills prepared for the jobs of the future and essential to maintaining the national innovation base. The NDS requires that DoD cultivate talent and build a more lethal force by creating a modern, agile, information-advantaged, motivated, diverse, and highly skilled civilian workforce. To support the NDS lines of effort the DoD civilian workforce must be equipped to use and integrate new and emerging technologies, such as those associated with the Office of the Secretary of Defense for Research and Engineering (OSD (R&E)) Modernization Priorities (e.g., space, hypersonics, machine learning, artificial intelligence, 5G, microelectronics, biotechnology). Additional information on the (OSD (R&E)) Modernization Priorities is available at https://www.cto.mil/modernization-priorities/. While designed to strengthen the STEM workforce pipeline, the DCTC program will promote public service and may also support targeting other Department critical skill gaps as determined by the Secretary of Defense.

Initial Implementation – Design

The DCTC design will leverage the significant experience the DoD has attracting and preparing top talent for highly technical careers in service to our nation as both military and civilian members of the Department. The Senior Reserve Officers' Training Corps (SROTC) provides tuition, stipend, allowances, and training in exchange for service as a commissioned officer. Similarly, the Science, Mathematics and Research for Transformation Scholarship-for- Service (SMART) program provides tuition, stipends, allowances, health insurance, and training through summer internships in exchange for a commitment as civil servant in the Department.

The DCTC will leverage the SMART construct and existing policy and features of the military SROTC programs. Just as SROTC has a military science curriculum, DCTC will have an undergraduate curriculum centered on public service in the DoD and designed to align the student's academic courses of study with a DCTC curriculum providing opportunity for exposure emerging technologies and opportunity to apply STEM knowledge to current technical challenges facing the DoD. The DCTC will employ internships alongside a robust slate of projects as well as opportunities fostering innovation and competition across DCTC units in the program.

As a scholarship-based program providing a direct path to a STEM and public service career, DCTC will draw from a diverse population and be a natural educational capstone to nation-wide kindergarten through grade 12 (K-12) STEM programs. With a strong corps framework, DCTC will stand apart from other scholarship programs, inspiring a diverse and talented applicant pool. DCTC graduates will strengthen DoD's human capital environment, contributing a uniquely-trained cohort experienced in STEM and DoD technical challenges, and growing the DCTC model into a prestigious pipeline for STEM and other critical DoD needs.

Initial Implementation – Section 2200h Program Elements

The DCTC program design approach will leverage program features of the military SROTC and SMART programs. Department of Defense Instruction (DoDI) 1215.08, "Senior Reserve Officers' Training Corps Programs", establishes policy and procedures for the program, to include establishment and maintenance of units. DCTC planning will follow the DoDI 1215.08 tenet that decisions regarding the establishment, operation, maintenance, and assessment of ROTC units be based on efficient allocation of limited resources to meet specific needs. In the case of DCTC, these are the STEM needs of DoD. Additionally, DCTC planning includes leveraging, where applicable, the SMART program as described in Federal Register Notice (FRN) 84, Number 25, Wednesday, February 6, 2019. Chapter 113, section 2200h, requires that the Secretary of Defense determine the following initial planning elements of the program:

1. **A methodology to identify and target critical skills gaps in Department of Defense occupations relating to acquisition, science, engineering, or other civilian occupations determined by the Secretary of Defense.**

   Initial Plan: DoD will use the DoD Modernization Priorities to inform identification and prioritization of critical STEM skill gaps, in addition to other STEM needs. The Modernization Priorities will inform the DCTC program design and content, including program curriculum, to engage students through hands-on application of application of STEM and skills-based learning to in-context DoD technical challenges and student projects.

2. **A mechanism to track and report the success of the program in eliminating any critical skills gaps identified under paragraph (1).**

   Initial Plan: DoD will track/report on DCTC graduates by STEM degree and will track alignment of DCTC curriculum and student projects to DoD Modernization Priorities.

3. **Criteria for an accredited civilian educational institution to participate in the program.**

   Initial Plan: DoD will consider availability of STEM courses/degrees and other offerings in fields strongly associated with DoD Modernization Priorities; availability of STEM courses/Degrees, to include the 21 SMART program-funded disciplines; availability of student opportunities to apply STEM skills; geographical proximity to DoD labs and acquisition and/or other organizations; existing partnerships with DoD labs and acquisition organizations; College/University support of ROTC students, infrastructure, resource and program needs; long term supportive partnering on DoD programs, to include ROTC programs; other self-identified college/university strengths; and willingness to establish partnership through resulting contract similar to SROTC contracts with universities/colleges.

4. **The eligibility of a student to become a member of the program.**

Initial Plan: DoD will maximize consistency of DCTC with the SMART Program competitive application process and criteria (Federal Register Notice (FRN) 84, Number 25, Wednesday, February 6, 2019). Eligible persons for DCTC must:

a. be a U.S. citizen at the time of application;
b. be 18 years or older at the time of entry into the program. (17 years with parental/guardian permission);
c. be willing to participate in summer internships at DoD laboratories or other DoD organizations;
d. accept post-graduation employment with DoD;
e. pursue an undergraduate degree in the SMART or DCTC program disciplines and remain in good standing with the DCTC host college/university with a minimum Grade Point Average of3.0 on a 4.0 scale and; and
f. be eligible to obtain and maintain a secret level security clearance.

5. **Criteria required for a member of the program to receive financial assistance from the Department of Defense.**

Initial Plan: To the extent practical, DCTC requirements will be consistent with the SMART Education Program's financial assistance requirements.

6. **The term of service as an employee of the Department of Defense required for a member of the program to receive such financial assistance.**

Initial Plan: Terms of service will align with the requirements of the SROTC program. For each academic year a DCTC student receives financial assistance, the student will be required to commit to two years of civilian employment with the DoD. DCTC members will enter into this obligation by means of a service agreement executed prior to entering the program. DCTC members who enter the program after the start of an academic year will incur a pro-rated service obligation proportionate to the portion of tuition funded by the program for that year.

7. **Criteria required for a member of the program to be released from a term of service.**

Initial Plan: Release criteria will align, as appropriate, to SROTC program criteria in 10 U.S.C. and to SMART program criteria elements of 10 U.S.C. section 2192a.

8. **The method by which a successful graduate of the program may gain immediate employment in the Department of Defense.**

Initial Plan: The Department will utilize its non-competitive direct hire authorities, to include the Department's Post-Secondary Students and Recent Graduate authority granted under section 1106 of FY 2017 NDAA, to appoint graduates into vacant civilian positions.

9. Resources required for implementation of the program.

Initial Plan: Resources will be used to plan and develop the program and curriculum, establish agreements and fund tenant costs at academic institutions, fund operational costs of centralized and unit staffing and support, and to fund the student costs of the DCTC program (e.g., tuition, room and board, stipends, internships, etc.).

DCTC program management will leverage infrastructure and other resources offered by prospective academic institutions and other partners, to include SROTC, SMART and other related programs. However, while there will be some opportunities in partnering with SROTC units, every effort will be made to ensure that the partnering will only strengthen and not diminish the mission effectiveness of the SROTC programs which are critical to the military officer pipeline. DCTC is not intended to compete with for SROTC talent but to bolster the pipeline of great talent into DoD. DCTC will provide an avenue for talented individuals who are not able to qualify or become unqualified for the military (e.g., for medical reasons), who represent the nation's diverse and great technical and other critical skills talent that desire to contribute through public service. Ideally, the investment in the DCTC program may be able to serve as a baseline program benefitting and making possible other related STEM (e.g., artificial intelligence, cyber, software) and other critical skill programs and initiatives. It is critical that the planning include not only up front resources to thoroughly plan and implement, but also to sustain a program agile and robust in curriculum that stays relevant to applying emerging technologies and innovating to solve DoD technical challenges as part of preparing our next generation workforce to continuously achieve overmatch.

Appendix B.
DoD STEM Workforce

STEM occupations cover a large number of occupational groups and series in the federal workforce including within the DoD. According to the Bureau of Labor Statistics there are over 100 STEM occupations including computer and information scientist, mathematician, engineer, life and physical scientist, and managers of STEM workers. Each of these occupations and functional areas within them generally require scientific or technical knowledge at the postsecondary level (U.S. Bureau of Labor Statistics n.d.).

Alternatively, the National Science Board identifies five S&E workforce areas: (1) computer and mathematics scientists; (2) biological, agricultural, and environmental life scientists; (3) physical scientists; (4) social scientists; and (5) engineers. They also note that middle-skill occupations require significant STEM expertise but do not require a bachelor's degree. These individuals, with a high level of skill knowledge in their technical domain and can perform their duties without a bachelor's degree (Okrent and Burke 2021), are referred to as the STW in this report. The middle-skill occupations are critical for adapting and maintaining new processes and technologies for the U.S. S&E enterprise. The U.S. Census Bureau's 2019 American Community Survey (ACE) noted that the number of middle-skill positions is almost equal to the number of individuals working S&E and S&E-related occupations combined (U.S. Census Bureau n.d.). In terms of numbers, ACE reported approximately 6.6 million individuals with bachelor's degrees or higher in S&E occupations. However, when STEM occupations are expanded to include those employed in S&E, S&E-related fields, and middle-skill occupations (the STW), about 36 million individuals (or 23 percent of the total U.S. workforce) work in STEM. It is clear that the size of the STEM workforce varies considerably with the inclusion of the middle-skill occupations and STW.

The DoD workforce consists of military Service members, contract personnel, and DoD civilian personnel. Eligibility for DoD civilian positions is determined by the roles one is expected to fulfill within a position. Eligibility for DoD positions is primarily determined by education level and/or experience level, but it may also be determined by additional factors (e.g., Veteran's status, citizenship). According to OPM, within the federal civilian personnel sector there are two broad categories of occupational groups, each containing STEM occupations. These categories are labeled, "White Collar Occupations" and "Trade, Craft, or Labor Job Families and Occupations" (U.S. OPM 2018). The "White Collar" category has 23 groups and the "Trade, Craft, or Labor Job

Families and Occupations" category has 36 groups that represent broad categories of occupations. For example, in the "White Collar" category there is an Engineering and Architecture Group. Within each Group, there are additional specific categories of occupations called a Series (e.g., the Civil Engineering Series, Electrical Engineering Series, and Mechanical Engineering Series). A Series title itself may reflect an occupation for a DoD Civilian (e.g., a Civil Engineer), or there may be a more specific occupation title within the Series that a DoD civilian can have (e.g., a Levee Safety Program Manager) (U.S. OPM 2018).

There are 46 occupational series, akin to job titles, identified within all of the functional career fields in the Defense Acquisition Workforce (DAW). The top 10 populated functional career fields have employees in 41 of these 46 occupational series. The top 20 populated occupational series within the 10 functional career fields are presented in Figure B-1. The term "engineer" or "engineering" is the title of seven and the term "analyst" or "scientist" is in the title of three of these occupational series. These results indicate that there likely is a large number of employees in the DAW that have some level of STEM education.

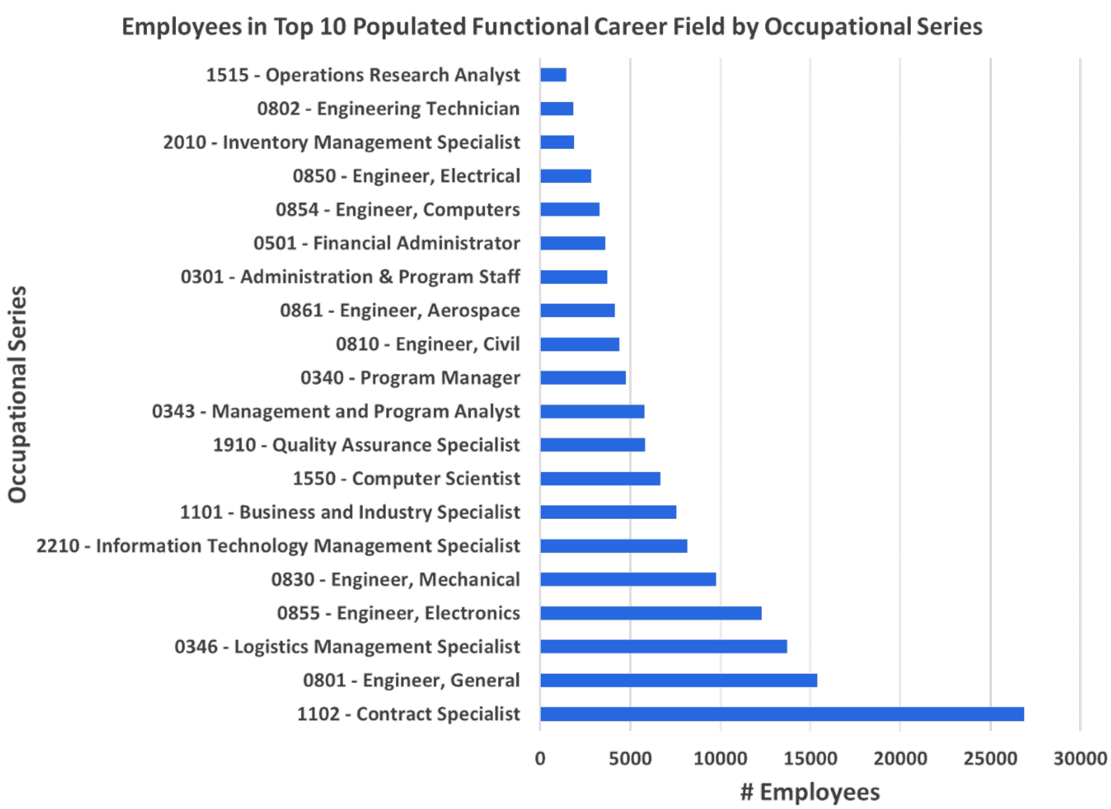

Figure B-1. Graphic depicts number of employees in top 10 most populated functional career fields by occupational series.

Appendix C.
Diversity in STEM

This appendix presents a deeper look into diversity in STEM by an analysis of the relationship among STEM disciplines, gender, and race/ethnicity. Across all S&E fields, women earned 48.7 percent of the bachelor's, 45.8 percent of the master's, and 45.8 percent of the doctoral S&E degrees in 2019 (Table C-1 shows porportion of degrees in S&E fields both across and within broad fields of study) (Trapani and Hale 2022). By examining the graduation rates by particular disciplines, the data tell a more complete story. For example, women received a majority of degrees in the agricultural sciences, biological sciences, and social sciences (particularly in psychology) across all degree levels in 2019. On the other hand, women earned only 20.6 percent of the bachelors, 32.8 percent of the master's, and 22.9 percent of the doctoral degrees in computer science during the same period. Likewise, women earned 22.7 percent of the bachelor's, 26.3 percent of the master's, and 24.6 percent of the doctoral degrees in engineering.

Table C-1. Science and Engineering (S&E) Degrees Awarded by Gender and Discipline, 2019

Discipline	Gender	S&E Degrees Awarded (2019)			
		Associate's	Bachelor's	Master's	Doctoral
All S&E Fields	Male	52.3%	51.3%	54.2%	52.2%
	Female	47.7%	48.7%	45.8%	45.8%
Engineering	Male	83.5%	77.3%	73.7%	75.4%
	Female	16.5%	22.7%	26.3%	24.6%
Agricultural Sciences	Male	55.4%	41.7%	41.6%	50.3%
	Female	44.6%	58.3%	58.4%	49.7%
Biological Sciences	Male	30.2%	36.3%	39.7%	48.1%
	Female	69.8%	63.7%	60.3%	51.9%
Computer Sciences	Male	80.0%	79.4%	67.2%	77.1%
	Female	20.0%	20.6%	32.8%	22.9%
Earth, Atmospheric & Ocean Sciences	Male	60.9%	58.3%	55.8%	70.4%
	Female	39.1%	41.7%	44.2%	29.6%
Mathematics and Statistics	Male	69.1%	57.7%	57.3%	70.4%
	Female	30.9%	42.3%	42.7%	29.6%
Physical Sciences	Male	57.1%	59.4%	64.2%	67.1%

Discipline	Gender	S&E Degrees Awarded (2019)			
		Associate's	Bachelor's	Master's	Doctoral
	Female	42.9%	40.6%	35.8%	32.9%
Psychology	Male	23.5%	20.9%	19.8%	28.2%
	Female	76.5%	71.9%	80.2%	71.8%
Social Sciences	Male	31.0%	44.2%	42.1%	49.9%
	Female	69.0%	55.8%	57.9%	50.1%

Note: Data derived from the National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Completions Survey.

Across racial/ethnicity groups there is variability in S&E-degree-attainment levels, in that some groups are more likely to be represented at one-degree level (i.e., associate's, bachelor's, master's, or doctorate) versus another. Table C-2 shows the results of the National Science Board analysis of the degree-level attainment for 2019 in S&E degrees. Hispanic individuals comprise 20 percent of the U.S. population between the ages of 20–34, and are over-represented in those receiving associate S&E degrees by earning 31 percent of all associate S&E degrees in 2019. However, Hispanics are under-represented slightly in bachelor's degrees and even less represented in master's and doctoral degrees in S&E fields. Conversely, White individuals (54 percent of the population) were under-represented in those receiving associate degrees, but over-represented in receiving higher-level degrees. Additionally, Black or African American individuals make up 14 percent of the population, but are under-represented at all degree levels, but more so at the bachelor's and doctoral levels versus the associate's and master's levels. On the other hand, Asians (who comprise 7 percent of the population) earned 11 percent of the S&E degrees.

Table C-2. Science and Engineering (S&E) Degrees Awarded by Degree Level and Race/Ethnicity, 2019

Degrees	S&E Degrees Awarded (2019)						
	American Indian or Alaskan Native	Asian	Black or African American	Native Hawaiian or Pacific Islander	White	Mixed Race	Hispanic
Associate's	1.0%	9.7%	10.1%	0.2%	43.7%	4.1%	31.1%
Bachelor's	0.4%	11.3%	8.7%	0.2%	58.8%	4.3%	16.3%
Master's	0.4%	11.1%	11.3%	0.2%	61.2%	3.6%	12.2%
Doctoral	0.4%	10.6%	8.1%	0.2%	69.1%	3.2%	8.4%

Note: Data derived from the National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Completions Survey. NCES reports each racial category by excluding persons of Hispanic ethnicity (i.e., Hispanic ethnicity is treated as a racial category). The data exclude individuals of unknown or other race.

Interestingly, there is an intersectionality between race/ethnicity and degree level for certain racial and/or ethnic groups. As such, Hispanic individuals earned a considerably larger proportion of associate degrees (see Table C-1) and a relatively smaller proportion of the doctoral degrees than the other degree levels. The remainder of the racial groups obtained approximately the same proportion of degrees across levels. Another level of intersectionality occurs when the number of S&E degrees obtained in 2019 is examined at the gender, race, and degree level (see Table C-2). While women earned just under half of all degrees in 2019 (see Table C-1), the actual proportion of degrees earned varied by ethnic and racial group. As such, American Indian/Alaskan Native, Black/African American, mixed race, and Hispanic women earned a higher proportion of S&E degrees in 2019 than Asian and White women. In fact, women in these ethnic and racial groups earned more degrees across all levels of degrees (with the exception of mixed-race women earning master's degrees) than men. Additionally, Native Hawaiian/Pacific Islander women earned more bachelor's and master's S&E degrees than their male counterparts (Table C-3).

Table C-3. Distribution of Science & Engineering (S&E) Degrees Conferred by Gender and Race/Ethnicity

		Race and Ethnicity						
Degrees	**Gender**	**American Indian or Alaskan Native**	**Asian**	**Black or African American**	**Native Hawaiian or Pacific Islander**	**White**	**Mixed Race**	**Hispanic**
All S&E Degrees	Male	0.2%	5.8%	3.6%	0.1%	30.5%	1.9%	7.5%
	Female	0.3%	5.0%	5.4%	0.1%	27.3%	2.2%	9.6%
Associate's	Male	44.0%	54.3%	47.2%	51.8%	60.0%	50.4%	41.8%
	Female	56.0%	45.7%	52.8%	48.2%	40.0%	49.6%	58.2%
Bachelor's	Male	43.1%	52.8%	39.1%	48.5%	52.3%	46.4%	43.9%
	Female	56.9%	47.2%	60.9%	51.5%	47.7%	53.6%	56.1%
Master's	Male	41.0%	55.7%	37.5%	42.0%	52.1%	51.6%	46.0%
	Female	59.0%	44.3%	62.5%	58.0%	47.9%	48.4%	54.0%
Doctoral	Male	42.3%	48.7%	30.9%	51.1%	49.9%	42.7%	54.6%
	Female	57.7%	51.3%	61.9%	48.9%	50.1%	57.3%	54.6%

Note: Data derived from the National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Completions Survey. "All S&E Degrees" includes data for all races and gender. The rows represent the degree levels. The male and female percentages add up to 100 percent. NCES reports the percentage distribution of STEM degrees (from degree-granting institutions) and certificates (from both degree- and non-degree-granting institutions) conferred to U.S. citizens and permanent residents. NCES includes the following as "STEM": biological and biomedical sciences, computer and information sciences, engineering and engineering technologies, mathematics and statistics, and physical sciences and science technologies. NCES reports each racial category by excluding persons of Hispanic ethnicity (i.e., Hispanic ethnicity is treated as a racial category). The data exclude individuals of unknown or other race.

Appendix D.
MSI and HBCU Background

Minority Serving Institutions (MSIs)

In order to ensure that the nation is leveraging the increased diversity of its population, particularly for developing a larger, well-trained, STEM workforce, employers, including the DoD, can turn to the more than 700 Minority Serving Institutions (MSIs). These institutions enroll almost 30 percent of all undergraduate degree seekers in the United States and a majority of the students at these universities identify as minorities (Espinosa et al. 2017). Because MSIs offer a variety of opportunities to access higher education by students such as those in under-represented racial and ethnic groups, low-income students, those who are the first-generation to attend college, adult learners, post-traditional,[12] and nontraditional students, MSI student bodies are the most diverse in America.

MSIs are categorized as historically defined or enrollment defined. Historically defined MSIs were created to provide access to institutes for higher education for specific minority groups (Espinosa et al. 2017) and include Historically Black Colleges and Universities (HBCUs) and Tribal Colleges and Universities (TCUs). Alternatively, enrollment-defined/driven MSIs are required to meet enrollment thresholds for certain populations of students. These institutions are federally required to have low general and educational expenditures (as determined by the Department of Education), are eligible for Title IV funding, and must grant degrees through public or private institutions. Hispanic-Serving Institutions (HSIs), Alaskan Native or Native Hawaiian-Serving Institutions (ANNHIs), Asian American and Native American Pacific Islander-Serving Institutions (AANAPISIs), Predominantly Black Institutions (PBIs), and Native American-Serving Nontribal Institutions (NASNTIs) receive federal designation as MSIs based on student enrollment and institutional expenditure thresholds.[13] Núñez et al. (2015) notes that because MSIs enroll diverse communities, they can qualify for more than one MSI category (e.g., some HBCUs could identify as HSIs).

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[12] Post-traditional students are over 25 years of age, work full time, are financially independent, or are connected with the military (National Academies of Sciences, Engineering, and Medicine 2019).

[13] A minimum of 10 percent of the undergraduate student body must be comprised of the respective minority group it is designated to serve at AANHIs, AANAPISIs, and NASNTIs while a minimum of 25 percent of the undergraduate enrollment at HSIs must be Hispanic. PBIs are non-HBCUs that serve a student body that is both low income and African American students comprise a minimum of 40 percent of the undergraduate enrollment (National Architectural Accrediting Board 2019).

We examined the enrollment rates for minority students at MSIs. The most complete dataset for this analysis comes from the 2016 U.S. Department of Education, Integrated Postsecondary Education System (IPEDS) (U.S. Department of Education, NCES 2016). We note a few considerations to keep in mind regarding the data. IPEDS provides enrollment data on only four types of MSIs: HBCUs, TCUs, HSIs, and AANAPISIs. As such, we can only examine the racial and ethnic identities of undergraduate students at these MSIs (e.g., in 2016, 55.9 percent of minority undergraduates were enrolled in one of these four types of MSIs). Relatedly, there are considerable differences between these MSIs in terms of the types of institutions (2- vs. 4-year, public vs. private vs. for-profit) they represent. For the purpose of our analyses regarding the ethnic and racial identities of enrolled students, we did not differentiate between the types of institutions; however, we do provide some details about the types of institutions for each type of MSI below.

Additionally, although we will not discuss the issues associated with racial and ethnic categories in higher education (see Allen, Jones, and McLewis (2019) for a summary of these issues), how race/ethnicity is reported in the data regarding student enrollment at MSIs has led to some challenges in analysis. For example, the racial and ethnic categories reported in the data are grouped as: 1) Native American or Alaska Native, 2) Asian American, and 3) Native Hawaiian or other Pacific Islander. However, AANAPISIs serve Asian American and Native American Pacific Islanders and AANHIs serve Alaskan Native and Native Hawaiian students. Because we do not have data that differentiates the enrollment rates for Native American, Alaskan Native, Native Hawaiian, and Pacific Islander students and because the 2016 enrollment numbers for these groups are small (e.g., 0.7 percent of the 2016 students identified as Native American or Alaskan Native and 0.3 percent as Native Hawaiian or Pacific Islander), we combined the data for Asian American, Native Hawaiian, and Pacific Islander (AANHPI) students. In doing so, we determined that 6.6 percent of undergraduates in 2016 identified as AANHPI. Further, we found that 21.6 percent of AANHPI students attended an AANAPISI. Finally, we observed that 42.5 percent of AANHPI students attended either an HBCU, a TCU, an HSI, or an AANAPISI.

Although HBCUs only make up 3 percent of all postsecondary institutions, they have been immensely successful in graduating African American students, particularly in STEM fields and for African American students who then go on to pursue STEM doctoral degrees (Fiegener and Proudfoot 2013). It is important to keep in mind that although a majority of students at HBCUs identify as Black/African American, students of other racial and ethnic backgrounds also attend HBCUs. For example, the 2016 total student enrollment at undergraduate institutions was 19.8 million, of which 2.6 million (or 13.0 percent) students identified as Black/African American (U.S. Department of Education, NCES 2021). This includes the 292,083 students enrolled in HBCUs in the fall of 2016 where 223,500 (i.e., 76.5 percent of students at these schools identified as African American). Figure D-1 shows the racial/ethnic identities of the students at HBCUs in 2016 both as a percent of the study body and enrollment numbers. White students made up 11.4 percent and Hispanic students made up 5.3 percent of the total student body at HBCUs in 2016.

The American Council on Education identified 35 public (8 four-year and 19 two-year) and 8 private non-profit (5 four-year and 3 two-year) TCUs in the United States (American Council on Education n.d.). A majority of the students (77.1 percent) attended public TCU institutions (67.1 percent attended a 4-year and 32.9 percent attended a 2-year college/university). In 2016, 11.8 percent of all Native American and Alaskan Native students were enrolled at a TCU. Again, although TCU student enrollment in 2016 was 77.8 percent Native American or Alaskan Native, 16.5 percent of the students identified as White (see Figure D-1).

HSIs are 2- or 4-year nonprofit institutions with at least 25 percent Hispanic undergraduate full-time equivalent enrollment and a high portion of students with financial need. The number of HSIs have grown—from 189 in 1994 to 366 in 2016 in the United States and Puerto Rico. Of the HSIs, about two-thirds are public (n = 236) and one-half are 2-year (n = 174) institutions. Although some institutions were created with the expressed mission to serve Hispanic populations, most HSIs have received this designation because of the fast-growing Hispanic population in the regional and local communities they serve. As such, most HSIs (81 percent) are concentrated in regions with larger Hispanic populations (and population growth), such as—California, Texas, Puerto Rico, Florida, New York, and New Mexico (Espinosa, Turk, & Taylor 2017). The American Council on Education (n.d.) noted that a majority of the students (90.0 percent) attended public HSIs (41.4 percent attended a 4-year and 48.9 percent attended a 2-year college/university). Although HSIs represent only 15 percent of all nonprofit institutions of higher education, they enroll the majority of Hispanic college students, with nearly two-thirds of all Hispanic students (Espinosa, Turk, & Taylor 2017). Further, in 2016, HSIs enrolled 91.6 percent of all Hispanic students pursuing postsecondary and graduate education. Again, although HSI student enrollment in 2016 was 49.0 percent Hispanic, 24.6 percent of the students identified as White (see Figure D-1).

In 2018, the American Council on Education reported that the existence of 105 AANAPISIs (74 4-year and 31 2-year) for the 2016 school year across the United States and its territories. A majority of the students (92.5 percent) attended public institutions (52.6 percent attended a 4-year and 39.9 percent attended a 2-year college/university). Like other minority groups, the AAPI population is quickly growing in the United States and is expected to account for 50 million people by 2060. This translates to a cumulative increase by 35 percent in 2- and 4-year college enrollment by AAPI students over the next decade (Vollman 2017). Enrollment data from 2016 shows that these AANAPISIs enrolled roughly 40 percent of all AAPI postsecondary students and awarded about 22 percent of all associate’s degrees and 21 percent of all bachelor’s degrees received by AAPI college students (Museus et al. 2018) in 2016. That being said, when looking at the racial/ethnic composition of the student body at AANAPISIs, more students actually identified as White (28.9 percent) or Hispanic (27.8 percent) relative to Asian American (19.1 percent) or Native Hawaiian or Pacific Islander (1.1 percent) (see Figure D-1).

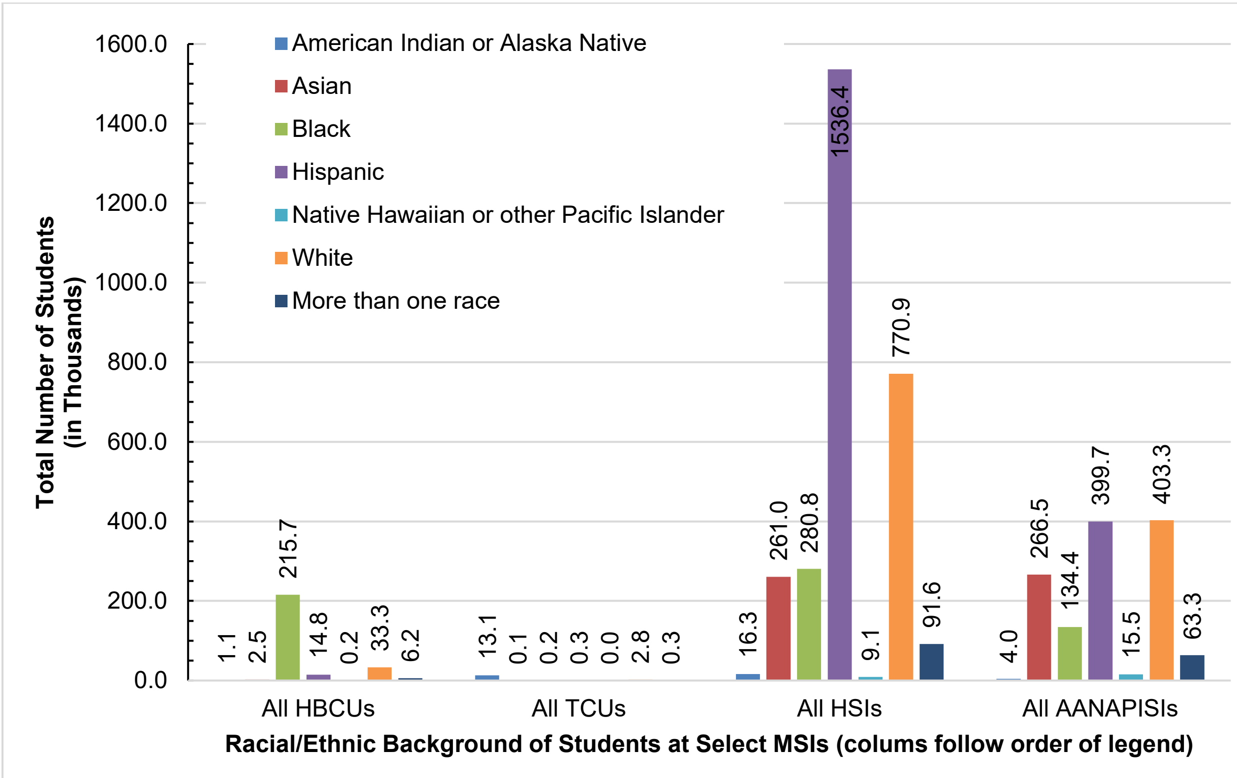

Figure D-1. Total number of students enrolled at HBCUs, TCUs, HSIs, and AANAPISIs by race/ethnicity. Note: The data exclude individuals of unknown or other race.

These data tell an interesting story. Although MSIs were set up to provide opportunities to access higher education by students such as those in under-represented racial and ethnic groups, there is some variability in how many minority students attend MSIs. This is an important consideration when conducting outreach and/or recruitment to increase diversity of any DoD scholarship program. For example, if the DoD is interested in recruiting Hispanic students into a scholarship program, HSIs might be a valuable site for outreach as they enrolled 91.6 percent of all Hispanic postsecondary and graduate students in 2016. On the other hand, if the DoD is interested in recruiting African American, Native American, or Alaskan Native students, HBCUs and TCUs might not provide access to a large segment of those groups for outreach opportunities as HBCUs only enrolled 13 percent of all African American students and TCUs only 11.8 percent of Native American and Alaskan Native students in 2016. Another consideration is the fact that although some MSIs enroll a majority of students that the designation was designed for (e.g., 73.8 percent of HBCU students identified as African American in 2016), this is not the case for all MSIs. For example, AANAPISIs primarily enrolled White and Hispanic students in 2016; however, the actual racial/ethnic identity of the student body depended on the institution—the student body at some institutions exceeded over 90 percent Asian American or Pacific Islander.

Finally, the DoD needs to consider the degree level of interest for their scholarship programs when recruiting from or conducing outreach to MSIs. There are a large number of both 2- and 4-year institutions that are designated MSIs. Some, such as HBCUs and TCUs, enroll a majority of students in 4-year programs (62.8 and 67.9 percent, respectively). Others, however, have approximately half of their students enrolled in 2-year programs. For example, 49.0 percent of students at HSIs and 40.1 percent of the students at AANAPISIs were enrolled in 2-year programs in 2017.

MSIs and STEM

The 2016 IPEDS data showed that there were slightly more undergraduate students enrolled in STEM fields at 4-year MSIs than at non-MSIs.[14] HBCUs, HSIs, and AANAPISIs together produced one-fifth of all STEM bachelor's degrees in 2016 and their STEM degree completion rates are either on par or exceed (e.g., HBCUs and AANAPISIs) non-MSI STEM degree awards. The 2016 IPEDs data show that HBCUs awarded 15.6 percent of all STEM bachelor's degrees earned by African American students; AANAPISIs awarded 18.8 percent of all STEM bachelor's degrees earned by Asian American students, and HSIs awarded 40.5 percent of all STEM bachelor's degrees earned by Hispanic students. Specifically, North Carolina A&T State University (public HBCU) awards the most engineering bachelor's and master's degrees to African American students. There are a number of universities that are the top suppliers of African American and Hispanic students to U.S. medical schools as well (e.g., Howard University, Xavier University of Louisiana, Spelmen College, University of Puerto Rico – Rico Piedras Campus, Florida International University, University of Texas Rio Grande Valley). That being said, few MSIs are research-intensive doctoral degree granting institutions, thus MSIs award substantially fewer STEM doctorates than do non-MSIs. Still, according to 2011–2014 NSF data, a significant number of Hispanic and African American students who pursue STEM doctoral degrees begin their postsecondary education at HSIs and HBCUs (National Science Foundation, National Center for Science and Engineering Statistics (NCSES) 2017).

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[14] These data show the following enrollment in STEM fields at MSIs: 43.3 percent at HSIs, 43.7 percent at HBCUs, 48.4 percent at AANAPISIs, and 40.0 percent at non-MSIs.

Appendix E.
School Selection Criteria

Schools	Frequency of CT	Artificial Intelligence	Biotech	Autonomy	Cyber	Directed Energy	Hypersonics	Space	5G	FNC3	Microelectronics	Quantum Science	HBCU/MSI	ROTC	UARC	State	Region
University of Maryland	8	X	X	X		X	X		X		X	X			X	MD	3
Purdue University	7		X	X		X	X		X		X	X		X		IN	5
John Hopkins University	6		X	X	X	X	X		X			X		X	X	MD	3
Massachusetts Institute of Technology	6		X	X		X			X		X	X		X	X	MA	1
Pennsylvania State University	6		X	X		X	X		X	X				X	X	PA	3
University of Michigan	6	X		X			X	X			X	X		X		MI	5
University of Virginia	6	X		X			X			X	X	X		X		VA	3
Carnegie Mellon University	5	X		X	X				X		X	X		X		PA	3
University of Colorado, Boulder	5	X		X			X		X			X		X		CO	8
University of Illinois at Urbana-Champaign	5			X			X			X	X	X		X		IL	5
University of Texas at Austin	5	X				X	X	X	X					X	X	TX	6
Duke University	4			X		X						X		X		NC	4
Georgia Institute of Technology	4			X			X			X		X		X	X	GA	4
Mississippi State University	4			X	X	X	X							X		MS	4

Schools	Frequency of CT	Artificial Intelligence	Biotech	Autonomy	Cyber	Directed Energy	Hypersonics	Space	5G	FNC3	Microelectronics	Quantum Science	HBCU/MSI	ROTC	UARC	State	Region
Northeastern University	4	X			X		X		X					X		MA	1
Stanford University	4			X					X	X		X				CA	9
Texas A&M University	4	X		X	X							X	HSI	X		TX	6
University of California, Berkeley	4		X		X				X		X			X		CA	9
University of Central Florida	4				X	X	X	X					HSI	X		FL	4
University of Iowa	4		X	X		X	X							X		IA	7
University of Texas at San Antonio	4			X	X		X		X				HSI	X		TX	6
University of Washington, Seattle	4	X		X			X					X	AANA/ PISI	X	X	WA	10
Virginia Tech	4			X	X		X		X					X		VA	3
Columbia University	3			X				X			X					NY	2
New York University	3		X		X				X							NY	2
Northwestern University	3		X			X						X		X		IL	5
Old Dominion University	3			X	X			X						X		VA	3
Princeton University	3		X						X			X		X		NJ	2
SUNY Buffalo	3					X	X					X				NY	2
The Ohio State University	3	X					X		X					X		OH	5
The University of Alabama in Huntsville	3					X	X	X						X		AL	4
The University of Arizona	3				X		X	X					HSI	X		AZ	9
University of Akron	3						X	X			X			X		OH	5
University of California, Los Angeles	3			X					X			X		X		CA	9
University of Cincinnati	3			X	X		X							X		OH	5

Schools	Frequency of CT	Artificial Intelligence	Biotech	Autonomy	Cyber	Directed Energy	Hypersonics	Space	5G	FNC3	Microelectronics	Quantum Science	HBCU/MSI	ROTC	UARC	State	Region
University of Oklahoma	3		X				X					X		X		OK	6
University of Pittsburgh	3	X	X				X							X		PA	3
University of Southern California	3	X					X					X		X	X	CA	9
University of Texas at Arlington	3			X		X	X						HSI	X		TX	6

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Abbreviations

AANHPI	Asian American, native Hawaiian, and Pacific Islander
ABET	Accreditation Board for Engineering and Technology
ACE	American Community Survey
ANNAPISI	Asian American and Native American Pacific Islander-Serving Institutions
ANNHI	Alaskan Native or Native Hawaiian-Serving Institutions
AWS	Amazon Web Services
CCNP	Cisco Certified Network Professional
CSIS	Center for Strategic and International Studies
CT	critical technology
DAPRA	Defense Advanced Research Projects Agency
DAU	Defense Acquisitions University
DAW	Defense Acquisition Workforce
DCAIP	Defense College Acquisition Internship Program
DCTC	Defense Civilian Training Corps
DoD	Department of Defense
DoDI	Department of Defense Instruction
FRN	Federal Register Notice
FY	fiscal year
HBCU	Historically Black College or University
HCI	Human Capital Initiatives
HSI	Hispanic-Serving Institution
IDA	Institute for Defense Analyses
IPEDS	Integrated Postsecondary Education System
KRL	Knowledge Readiness Level
MI	Minority Institution
MSSE	Microsoft Certified Solutions Expert
MSI	Minority Serving Institution
NASNTI	Native American-Serving Nontribal Institution
NCES	National Center for Education Statistics
NCSES	National Center for Science and Engineering Statistics
NDAA	National Defense Authorization Act
NDS	National Defense Strategy
NSB	National Science Board
NSF	National Science Foundation
OPM	Office of Personnel Management
OSD(R&E)	Office of the Secretary of Defense for Research and Engineering
OTS/OCT	Officer Candidate School/Officer Candidate Training

OUSD A&S	Office of the Under Secretary of Defense for Acquisition and Sustainment
OUSD P&R	Office of the Under Secretary of Defense for Personnel and Readiness
PBI	predominantly Black institution
ROTC	Reserve Officer Training Corps program
S&E	science and engineering
S&T	science and technology
SF	sponsoring facility
SMART	Science, Mathematics, and Research for Transformation
SPO	SMART Program Office
SROTC	Senior Reserve Officers' Training Corps
S&T	science and technology
STEM	science, technology, engineering, and mathematics
STW	skilled technical workforce
TCUs	Tribal Colleges and Universities
TRL	Technology Readiness Level
UARC	University Affiliated Research Center

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14. ABSTRACT

The National Defense Authorization Act for Fiscal Year 2020 directed the Secretary of Defense to establish and maintain a Defense Civilian Training Corps (DCTC). The initial implementation design aligned with the National Defense Strategy along with the following features: scholarship-for-service requirement, 4-year curriculum, internships, and focus on critical technology challenges. The Institute for Defense Analyses (IDA) was asked to design alternative options for implementing DCTC. IDA designed four alternatives: 1) 2-year scholarship-for-service program with summer internships and DCTC curriculum, with potential for additional education post-graduation; 2) 2-year scholarship-for-service program with internships and curriculum for students entering the skilled technical workforce (i.e., technical positions that do not require bachelor's degree); 3) focus on summer internships with an abbreviated DCTC curriculum; and 4) leverage pre-existing Department of Defense (DoD) programs, in which the DCTC curriculum is provided. The report describes relevant factors and potential trade-off issues for deciding on program design. The DoD has an opportunity to create a unique workforce program to bring in talent to address critical technology challenges, but this will require regular monitoring of its shifting requirements to adapt the program as the Department's needs change.

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advanced education; Human Capital; Scholarship for Service; STEM workforce development

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