DoD T2 Impact Model Project

Recommendations to Improve Technology Transfer (T2) Outcomes and Impacts on the Defense Mission and National Economy

FINAL REPORT, MARCH 2023

TechLink

The Department of Defense's National Public-Private Partner for Technology Transfer

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Acknowledgments

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Executive Summary

Purpose and Scope

This study analyzes the current Department of Defense (DoD) technology transfer (T2) system, diagnoses its shortcomings, and develops a model of an improved T2 system. In addition, it provides a comprehensive set of recommendations to help implement this new system. The overriding purpose is to help DoD policymakers improve the effectiveness of the DoD T2 system and increase its outcomes and impacts on the defense mission and national economy. The study was commissioned by the Office of the Under Secretary of Defense for Research and Engineering and undertaken by TechLink, which has served as DoD's national T2 partnership intermediary since 1999.

Purpose: To help DoD policymakers improve the effectiveness of the DoD T2 system and increase its outcomes and impacts on the defense mission and national economy.

The study encompasses all six stages of the DoD T2 – Technology Transition Pathway, from initial research and development (R&D) in the DoD labs to the ultimate impacts of this R&D. Its focus is on license agreements and Cooperative Research and Development Agreements (CRADAs). Other T2 mechanisms have important functions. However, licenses and CRADAs are the principal means by which DoD T2 achieves an impact on the defense mission and national economy.

Tasks Undertaken and Results

The study involved five separate tasks:

1. Reviewing journal articles and U.S. government reports on T2 appearing since 2000 for insights and information that could help accomplish the project objectives.
2. Conducting in-depth interviews with DoD and private-sector personnel to diagnose shortcomings in the current DoD T2 system and generate ideas for improvement.
3. Constructing a logic model of the current T2 system focusing on inputs, activities, outputs, outcomes, and impacts.
4. Developing a logic model of an improved DoD T2 system to increase its impacts on the defense mission and U.S. economy.
5. Formulating a detailed, prioritized set of recommendations to help DoD policymakers implement this new model.

The T2 literature review discovered relatively few publications that provided practical steps federal agencies can take to improve their T2 processes and metrics. To complement this review, TechLink conducted 200 interviews. These included an initial round of 165 in-depth interviews and 35 follow-up interviews. Interviewees included 131 DoD personnel and 34 company executives whose firms had previously engaged in T2 with DoD labs. All interviews included both "yes" or "no" questions and open-ended queries to generate detailed responses.

Interviews with DoD personnel involved 73 different DoD organizations and included T2 managers, scientists and engineers (S&Es), lawyers, lab leaders, and acquisition program managers. Participating labs ranged in size from 28 S&Es to over 10,000 S&Es. Companies varied from two-person startups to Fortune 500 corporations with over 60,000 employees.

Extensive interviews with DoD and private-sector personnel revealed substantial shortcomings throughout the DoD T2 system…from initial inputs to ultimate impacts.

These interviews revealed substantial shortcomings in all elements of the current DoD T2 system. Deficiencies were found to extend from the system's initial inputs through its activities, outputs, outcomes, and impacts. These deficiencies included inadequate staffing and funding; insufficient training; weak support from DoD leadership; inadequate disclosure of inventions by S&Es; low numbers of patents relative to DoD's total R&D expenditures; lack of standardized and streamlined T2 agreements across DoD; a T2 process that industry regards as overly bureaucratic and time consuming; lack of procedures and metrics to track the outcomes of completed T2 agreements; inadequate communication between DoD labs and acquisition programs and low use of Technology Transition Agreements (TTAs); and lack of effective, funded mechanisms to accomplish transition of DoD lab technologies to DoD operational use. These shortcomings prevent the T2 system from achieving its high potential to have a major impact on the defense mission and national economy.

Logic Model of the Current DoD T2 System

Findings from the interviews enabled the TechLink team to construct a logic model of the current DoD T2 system. This model graphically portrays DoD's T2 system and details the major deficiencies in each of its elements: inputs, activities, outputs, outcomes, and impacts. Many of these deficiencies derive from DoD's limited vision for its T2 system.

The model reveals that both the scope and strategic vision of DoD's T2 operations are highly limited. T2 operations are perceived to include only the T2-related inputs, activities, and outputs. These operations are essentially considered complete when a license or other T2 agreement is executed or CRADA project ends. There is virtually no follow-up to determine what happens after DoD-developed or co-developed inventions leave the lab. Metrics used by DoD to evaluate its T2 operations focus almost exclusively on activities and outputs, such as the numbers of invention disclosures, issued patents, and T2 agreements. They essentially ignore the outcomes and impacts.

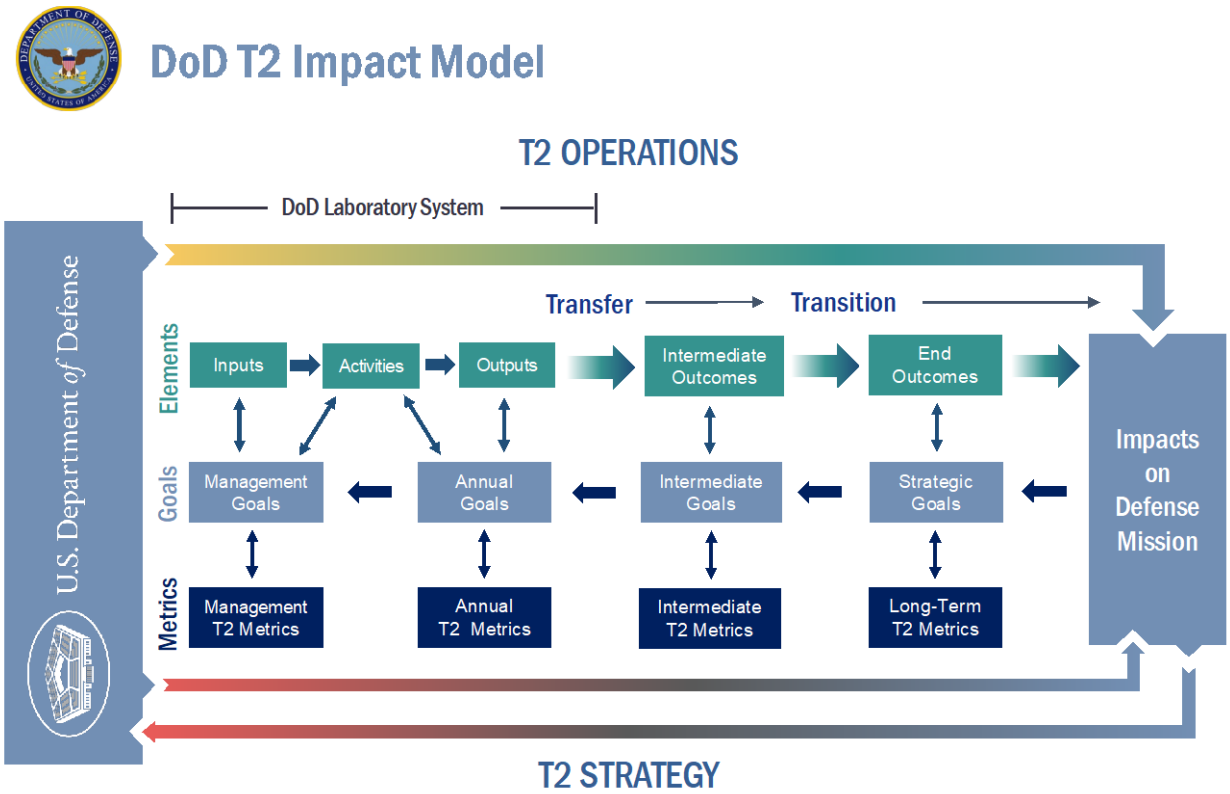
The basic strategic goal is to generate T2 agreements. There is no explicit strategy that includes concrete steps, milestones, and metrics to enable the T2 system to achieve an impact on the defense mission. In fact, there is a major disconnect between DoD's T2 operations and its technology transition programs. It is poorly understood within DoD that T2 is an important and cost-effective pathway to achieve transition of

innovative new technology to U.S. military use. As a result, DoD's T2 operations fall substantially short of having a major impact on the defense mission.

DoD T2 Impact Model: An Improved DoD T2 System

Constructing the logic model of the current DoD T2 system enabled the TechLink team to envision the changes needed to improve this system and design a new T2 model to overcome the current system's shortcomings. The resulting DoD T2 Impact Model embodies a major paradigm shift in how technology transfer is viewed by DoD. Currently, T2 operations are perceived to end at the point of transfer. By contrast, in the new model, T2 operations are considered to extend all the way to the ultimate impacts on the defense mission. In this model, DoD T2 is re-envisioned and re-engineered to become one of DoD's most important pathways to technology transition.

The DoD T2 Impact Model accomplishes several important goals. It enables DoD leaders to track DoD lab inventions and T2 agreements to their ultimate outcomes, so they can evaluate the impact of DoD's R&D and T2 operations on the defense mission. It also enables DoD leaders to develop a comprehensive T2 strategy—one that seamlessly interconnects T2 with technology transition in an integrated effort to deliver innovative technology to the U.S. Warfighter. Finally, this new model incorporates effective metrics for each stage in the T2 process, to help obtain the desired outcomes and impacts on the defense mission.



Project Recommendations

To help DoD leaders implement the DoD T2 Impact Model, the project team developed a comprehensive list of recommendations (including metrics), drawn largely from the in-depth interviews. These recommendations were organized in four different ways:

First, they were grouped according to the element in the T2 system to which they pertain—inputs, activities, outputs, intermediate outcomes, end outcomes, or impacts.

Second, they were sorted into three different tiers, each tier indicating the relative difficulty of implementation.

Third, they were ranked with scores from 1 to 5 to indicate the anticipated impact or benefit from their implementation.

Fourth, they were assigned labels to indicate which of the following six functional categories they address: strategy and policies; resources; education and training; processes and procedures; acquisition; or metrics.

The project generated a total of 232 specific recommendations for consideration by DoD policymakers, including 44 proposed new metrics. Of these, 64 recommendations (including 28 new metrics) were given a top score of 1.

Implementation of the DoD T2 Impact Model, with the proposed recommendations and new metrics, can be immediately initiated but will take several years to fully accomplish (see the following schedule). Tier I recommendations—the low-to-no-cost solutions—should be able to be implemented in the first one to two years. Tier II recommendations, requiring some additional funding and/or policy changes, could realistically take two to three years to execute. Finally, Tier III recommendations, which require substantial additional funding and policy changes, may take three or more years to fully implement.

DoD T2 Model Implementation Schedule

	Years				
Recommendations by Tier	**1**	**2**	**3**	**4**	**5**
TIER I: Low-to-no-cost solutions that can be readily and immediately implemented					
TIER II: Solutions that will require some additional funding and/or policy changes					
TIER III: Solutions that will require substantial additional funding and policy changes					

Bottom Line

For the DoD T2 system to realize its potential to have a major impact on the defense mission and national economy, DoD needs to undertake the following **ten key reforms**. These reforms embody the essence of the DoD T2 Impact Model and the 232 specific recommendations:

1) Develop and deploy a strong DoD T2 strategy that extends from initial inputs to the desired end results, seamlessly integrates T2 with technology transition, focuses on achieving substantial impacts on the defense mission, and employs robust metrics to help ensure the success of this strategy.
2) Provide sufficient resources (including personnel and funding) to enable all DoD labs to effectively conduct their legally mandated and DoD-required T2 functions in support of the defense mission.
3) Educate and train relevant DoD personnel (T2 and legal staff, S&Es, lab leaders, acquisition program managers, and DoD policymakers) so they understand the importance of intellectual property (IP) protection and T2, comprehend the legal requirements for these activities, strongly support them, and can effectively participate in achieving their success.
4) Establish mechanisms and metrics to enable DoD to effectively track and evaluate its T2 operations, from initial inputs to the ultimate impacts of license agreements and CRADAs on the defense mission.
5) Motivate S&Es and lab leaders to fully support IP protection, T2, and technology transition by providing the necessary incentives, training, funding, and assistance and by annually evaluating these personnel on their participation in these activities.
6) Streamline T2 procedures at all DoD labs by implementing best practices and establishing standardized business-friendly CRADA and license agreement templates, to make the process more rapid and cost-effective when DoD labs and industry engage in T2 partnerships.
7) Equip all DoD labs with a robust T2 management system to facilitate and automate IP- and T2-related activities, including initial invention disclosures, patent docketing, T2 agreement generation, and management of patents and licenses.
8) Effect changes to substantially increase the use of T2 to achieve transition of new technology to the U.S. Warfighter, recognizing that this is a cost-effective, underutilized way to enable DoD to benefit from innovations emerging wholly or partly from its own R&D labs.
9) Establish strong, user-friendly mechanisms to identify and transition critically needed DoD-developed or co-developed technologies to acquisition programs and U.S. military use via the T2 pathway.
10) Develop and implement an effective communication strategy to tell the story of how, through technology transfer, the DoD laboratory system benefits the defense mission, national economy, and American public.

Anticipated Results

Anticipated results from implementation of the new DoD T2 Impact Model and associated recommendations include increased engagement of U.S. industry and academia in developing new defense-related technologies; an increased number of new products resulting from T2 agreements; DoD T2 becoming a major pathway to deliver innovative technology to the U.S. Warfighter; substantial increases in DoD lab technologies being transitioned to operational use; expanded spin-in of cutting-edge private-sector technologies to DoD operations; and increased recruitment of innovative companies to the defense industrial base.

Major impacts

Major impacts from implementation of the DoD T2 Impact Model will include accelerated development of new defense-related technology; an increased stream of innovative technology to the U.S. military; expanded defense mission capabilities; a stronger, more agile and diverse defense industrial base; enhanced national development; and increased U.S. technological competitiveness

I. Project Overview

This study analyzes the current Department of Defense (DoD) technology transfer (T2) system, diagnoses its shortcomings, and develops a model of an improved T2 system. In addition, it provides a comprehensive set of recommendations to help DoD policymakers implement this new system.

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The study was commissioned by the Director of Technology Transfer and Commercial Partnerships in the Office of the Under Secretary of Defense for Research and Engineering. TechLink was tasked with conducting this study. TechLink has been DoD's national T2 Partnership Intermediary since 1999. Its primary mission is helping the DoD laboratory system broker licenses and other T2 agreements with industry to benefit the defense mission and national economy. In addition, TechLink regularly conducts studies of the national economic impacts resulting from DoD's T2 operations, produces success stories of notable T2 achievements, and provides essential training and education to T2 stakeholders, including T2 managers, S&Es, and lab leadership.

This study encompasses all key stages of the DoD T2 – Technology Transition Pathway. As Figure 1 shows, the first stage involves R&D within the DoD laboratory system, which potentially leads to new inventions. In the second stage, these DoD inventions are identified, protected, and managed. In the third *Technology Transfer* stage, DoD lab inventions are licensed to companies or Cooperative Research and Development Agreements (CRADAs) are established with industry for co-development of new technology. In the subsequent *Product Development and Sales* stage, DoD's private-sector T2 partners convert the DoD-developed or co-developed technologies into new commercial, dual-use (military and civilian), or strictly military products and services. In the *Technology Acquisition and Transition* stage, the militarily relevant products or services are acquired by DoD and deployed by the U.S. military. In the final stage, DoD T2's impacts on the defense mission and U.S. economy are realized. In short, this study encompasses the entire DoD T2 – Technology Transition Pathway—"from minds to markets" and from the marketplace to the battlespace.

In Figure 1, the X-axis indicates elapsed time, and the Y-axis represents increasing value. To the extent that new inventions or technologies progress along the pathway through the key stages of development, they increase in potential or actual value. For example, a new technology idea has virtually no value until its feasibility has been demonstrated through rigorous R&D. It acquires additional value after it has been protected via a patent application and significantly more value if the U.S. Patent and Trademark Office (USPTO) deems it to be "novel, useful, and non-obvious" and grants patent status.

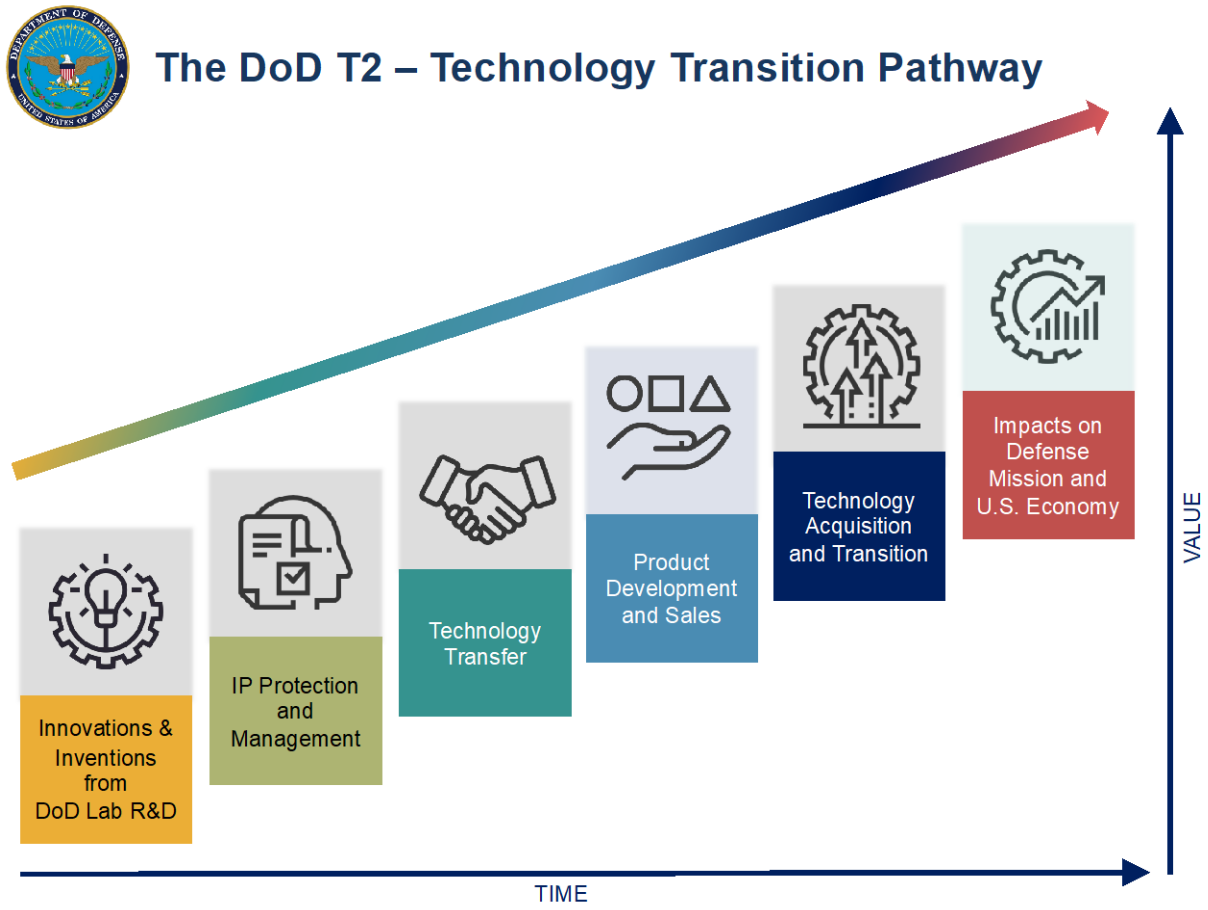


Figure 1. The DoD T2 – Technology Transition Pathway

If a company decides to license the DoD invention or co-develop new technology with DoD under a CRADA, and then makes the often-substantial investment to convert it into a product, the innovation accrues further value. If this product development is successful, and the company generates commercial sales, the innovation becomes financially valuable. Next, from the DoD perspective, if a dual-use or strictly military product based on the innovation is transitioned to DoD operational use, it achieves mission-related value. Finally, if this product results in notable impacts on the defense mission and/or national economy, the invention or new technology reaches the pinnacle of its potential value.

Technology transfer is both a legal obligation and DoD requirement. Federal agencies are legally required to attempt to transfer their inventions to industry "to ensure the full use of the results of the Nation's Federal investment in research and development." Federal statute 15 USC §3710 obliges all federal labs to establish dedicated T2 offices and personnel, makes T2 the responsibility of every lab scientist and engineer, and requires federal agencies to annually report their T2 metrics to the Office of Management and Budget as part of their annual budget submission. Additional legislation (10 USC §2514) specifically directs DoD to engage in T2 in order to strengthen the national technology and industrial base.

DoD Instruction (DoDI) 5535.08, titled *DoD Domestic Technology Transfer Program*, reinforces the above legislation. This 23-page issuance, dating back to 1999, was updated and reissued on September 22, 2022. It declares that "T2 is an integral element of the DoD national security mission..." and that "T2 activities play a high-priority role in all DoD programs and are recognized as key activities of DoD laboratories..."

DoDI 5535.08 fully delineates DoD's T2 policy and lists the responsibilities of the Deputy Chief Technology Officer for Science and Technology and DoD component heads in overseeing this policy and the agency's T2 activities. Responsibilities of DoD component heads include (1) ensuring that T2 is a responsibility of each DoD laboratory and of all DoD lab S&Es; (2) making T2 a priority in accomplishing the component's programs; (3) establishing T2 policies within their components for protecting and licensing their inventions; (4) establishing and supporting Offices of Research and Technology Applications (ORTAs)[1] in their labs to execute the DoD T2 function; and (5) otherwise ensuring full compliance with DoDI 5535.08.

The main body of DoDI 5535.08 explains the T2 procedures to be followed, including the use of T2 authorities; reporting requirements; procedures for identifying, protecting, and licensing DoD inventions and other IP; and guidelines and factors to consider when using CRADAs and partnership intermediaries. This Instruction concludes with a glossary of key T2-related terms.

Besides the legal requirement for DoD to engage in T2, there are compelling mission-related reasons. T2 leverages industry's expertise in developing technologies and converting these technologies into useful products and services. While the majority of the basic research in the United States takes place at universities and federal labs, most of the nation's applied R&D, and virtually all of its product development, is conducted by industry. T2 harnesses industry's development expertise to get DoD inventions into the hands of the U.S. Warfighter in a timely fashion.

T2 also provides a cost-effective way to develop new technology for DoD use. Basic research accounts for only a small percentage of the total development cost of a new military product. When DoD makes this initial investment in its own labs, then transfers the innovations to the private sector, its industry partners cover the bulk of the development expense. Furthermore, unless DoD lab inventions are transferred to industry, they are not likely to be put to operational use. DoD is not in the business of manufacturing equipment, weapons, and supplies. Instead, it needs to transfer its inventions to industry for conversion into new products that the U.S. military can procure.

In addition, T2 lowers the cost and improves the supply chain for military products that also have civilian applications. Often, the commercial market for dual-use products is larger and more constant than the military market. Commercial sales resulting from T2 create economies of scale that reduce DoD's procurement costs. Ongoing commercial sales help sustain the defense industrial base and ensure a more reliable supply of the military versions of these products. They also ensure ongoing development of the new technologies.

Finally, T2 engages innovative, agile companies that are not traditional defense contractors. Most DoD T2 partners are small or medium-sized businesses that have not previously interacted with the DoD. Many are highly innovative and entrepreneurial. Their capabilities greatly enhance the defense laboratory enterprise and strengthen the overall U.S. defense mission.

DoD initiated this project to assist in achieving these mission-related results. The overriding purpose was to improve the effectiveness of the DoD T2 system. The specific project goal was to develop a DoD T2

1 The acronym, "ORTAs," is also used informally when referring to the managers of these T2 offices.

Impact Model to function as an effective policymaking, management, and evaluation tool. This model, and the associated recommendations and proposed new metrics, are intended to help DoD policymakers improve the effectiveness of the DoD T2 system and increase its outcomes and impacts on the defense mission.

This project's focus is on license agreements and CRADAs. Other T2 mechanisms have important functions. However, patent license agreements (PLAs), CRADAs, and other types of license agreements (such as software and biological materials licenses) are the principal means by which DoD T2 achieves an impact on the defense mission and national economy.

TechLink launched this project in July 2021. The TechLink team conducting the project consisted principally of five T2 professionals who collectively have more than 100 years of hands-on experience with DoD T2 (Appendix 1). The project was completed in March 2023. (Appendix 2 shows the project schedule, broken down by task.)

II. Scope of Work

Specific Objectives

The Office of the Secretary of Defense (OSD) scope of work consisted of the following specific objectives:

- Define the desired outcomes and impacts from the DoD T2 system that will contribute most effectively to the U.S. defense mission.
- Identify T2 metrics that can be used to assess if this system is achieving these desired outcomes and impacts.
- Develop a comprehensive DoD T2 Impact Model that fully captures the inputs, outputs, outcomes, and impacts required for an improved DoD T2 system.
- Use the T2 Impact Model to help identify the key factors that facilitate or hinder the achievement of high-value T2 outcomes and impacts.

Five Tasks:

TechLink worked to accomplish the overriding project purpose and specific objectives by undertaking the following five tasks:

- Identifying and analyzing relevant studies and reports for information and insights to assist in achieving the project purpose and specific objectives.
- Interviewing select members of the DoD laboratory system, acquisition community, and private sector to diagnose the current DoD T2 system and develop recommendations to improve this system and ensure it is well-aligned with DoD mission needs.
- Developing a logic model of the current DoD T2 system—focusing on inputs, activities, outputs, outcomes, and impacts—to provide a comprehensive view of how this system functions and help detect shortcomings and areas for improvement.
- Developing a DoD T2 Impact Model, representing an improved DoD T2 system, using information and insights from extensive interviews, relevant studies and reports, and analysis of the current DoD T2 system.
- Formulating a detailed, prioritized set of recommendations to help DoD policymakers implement this new model.

III. Activities and Results

This section summarizes the activities and results associated with the tasks undertaken: the literature review, interviews of DoD and private-sector personnel, analysis of the current DoD T2 system, development of the DoD T2 Impact Model, and formulation of a comprehensive set of recommendations and metrics for implementation of this new model. For each task, we discuss the methodology employed and results achieved.

Task 1: Literature Review

Identify and analyze relevant studies and reports that can assist in achieving the project purpose and specific objectives.

Methodology

TechLink conducted a thorough review of the existing English-language literature on technology transfer to glean information and insights that could assist in achieving the project objectives. This review focused primarily on publications in the United States appearing between roughly 2000 and the present. It examined both academic and government policy-oriented literature. The former consists mainly of peer-reviewed articles in scholarly journals; the latter of reports from studies conducted or commissioned by the U.S. federal government.

TechLink conducted a thorough review of peer-reviewed journal articles and U.S. government reports on T2 appearing over the past two decades, seeking insights and information that could help achieve the project objectives.

Relevant publications were identified, in part, through extensive online research using various search engines such as Google Scholar as well as the Montana State University Library "Articles and Research Database" collection, which consists of over 240 databases covering approximately 100,000 scholarly journals and other periodicals. In addition, pertinent government reports were identified using specialized U.S. government search engines such as *gao.gov* and the website of the Institute for Defense Analyses, *ida.org*. This online research employed combinations of the following keywords and terms: *federal laboratory, university, technology transfer, licenses, patents, CRADAs, models,* and *metrics.* The research team also directly consulted the references cited in recent comprehensive literature reviews focusing on federal agency T2 (e.g., Peña and Novak 2021; Peña and Mandelbaum 2020; and Link et al. 2019) to identify relevant publications.

Using these search methods, the project team was able to identify approximately 50 publications that appeared to be directly relevant and potentially helpful. These publications were carefully reviewed for information and insights that could guide the project and assist in the development of a robust DoD T2 Impact Model.

Summary of Results

The literature review revealed a surprising lack of publications on practical steps that U.S. federal agencies can take to improve their T2 processes and metrics. Compared to the literature on university T2, relatively little has been written about U.S. federal agency T2.

Most of the academic, peer-reviewed literature focuses on university T2. In addition, most of this academic literature was found to be theoretical or conceptual rather than practical in nature. Almost none was written

by T2 professionals. Authors typically were social scientists striving to better understand technology transfer rather than trying to offer actionable improvements. Many of these authors evinced little practical understanding of technology transfer, particularly of federal agency T2. In fact, academic journal articles focusing on federal T2 were frequently found to present conclusions that are already well understood among T2 professionals, not grounded in operational reality, simply naïve, or merely common sense.

The government policy-oriented literature was more directly relevant. The project team identified several dozen reports from studies on federal agency T2 that were commissioned or conducted by the U.S. government. The explicit purpose of virtually all these studies was to evaluate the success of federal agency T2 or to recommend steps that agencies could take to improve their T2 processes. Unfortunately, most of these reports focused on T2 issues across the entire federal laboratory system and were overly general. As a result, they were of limited utility to this project.

> "The literature review revealed a surprising lack of publications on practical steps that U.S. federal agencies can take to improve their T2 processes and metrics."

Of the approximately 50 publications that initially appeared to be both relevant and potentially helpful, fewer than two dozen were found to offer truly useful information or insights. Of these, two publications, both government-sponsored reports, proved to be important resources for this project: (1) a report by the Institute for Defense Analyses that used a logic model framework to analyze DoD's use of partnership intermediary agreements (PIAs) for T2-related services (Peña et al. 2021), and (2) a RAND Corporation study that demonstrated how logic models can be effectively used to conceptualize DoD laboratory T2 programs and evaluate their success (Landree and Silberglitt 2018). Together, these two publications illustrated effective use of logic models for evaluating technology transfer. More specifically, they provided a valuable roadmap for developing logic models of the DoD T2 system.

A complete, 17-page summary of the literature review is presented in Appendix 3. The publications cited in this review and elsewhere in the report are listed in the Bibliography, Appendix 4.

Task 2: Interviews

Interview select members of the DoD laboratory system, acquisition community, and private sector to diagnose the current DoD T2 system and develop recommendations to improve this system and ensure it is well-aligned with DoD mission needs.

Methodology

TechLink conducted **200 interviews** with diverse members of the DoD laboratory system, DoD acquisition community, and private sector. The express purpose of these interviews was to gain insights and information on how to improve the DoD T2 system and ensure it is well-aligned with DoD mission needs.

> TechLink conducted 200 interviews with DoD personnel and private-sector executives for guidance on how to improve the DoD T2 system and ensure it is well-aligned with DoD mission needs.

TechLink initially proposed to conduct a minimum of 120 in-depth interviews with individuals within the DoD lab system and program management offices. These interviews were to include at least 35 interviews each with Army, Navy, and Air Force personnel, along with an additional 15 interviews with individuals in the independent defense agencies, such as the National Security Agency.

During preparations to initiate the interviews, however, two significant changes were made: *First*, the TechLink team decided to interview at least 30 top-level executives in companies that had previously engaged in license agreements and/or CRADAs with DoD labs, recognizing that DoD's T2 partners play an essential role in converting lab technologies into new commercial and military products. *Second*, the TechLink team decided to conduct the Task 2 interviews in two separate surveys: (1) an initial survey to diagnose problems with the current T2 system and solicit recommendations for improvements, and (2) a follow-up survey to obtain additional information, as needed, after the initial survey results had been analyzed.

The interview questionnaires were tailored to fit the different activities and objectives of each of the interview groups—T2 personnel, legal counsel, S&Es, lab leadership, acquisition personnel, and private-sector executives. These questionnaires were designed to be administered over the telephone in less than an hour. They consisted of both "yes" or "no" questions as well as open-ended queries intended to elicit detailed responses. Questions were strategically formulated to diagnose critical shortcomings and elicit recommendations for improvements. (See Appendix 5 for the interview questions for each of the survey groups.)

TechLink opted to conduct interviews of this type, rather than administer an electronic survey, in order to promote engagement and enable the research team to immediately ask follow-up questions and obtain in-depth answers. To help ensure candid responses, interviewees were assured, *first*, that their responses would be kept entirely confidential, treated as privileged information, and not attributed to any individual or lab, and *second*, that no names of respondents would appear in the project report.

Dr. Phuong Kim Pham, Director, Technology Transfer and Commercial Partnerships in the Office of the Under Secretary of Defense for Research and Engineering, provided an official memo addressed to both DoD and private-sector personnel explaining the purpose of the study and TechLink's role in conducting it. This memo clearly stated that TechLink would maintain the confidentiality of all responses and not attribute responses to any of the participants or labs in the study. The T2 program managers for the Army, Navy, and Air Force introduced the study to the laboratory T2 managers ("ORTAs") under their purview and encouraged their participation. John Dement, the OSD Technology Transfer Senior Advisor, did likewise for the independent defense agencies.

The OSD memo, high-level introductions, and assurance of confidentiality helped obtain a high level of participation in the survey. In addition, participation was fostered by the fact that many of the interviewees already knew the research team members or were aware of TechLink as DoD's national T2 partnership intermediary. For example, Kristen Schario, who spent six years as an AFRL engineer followed by over 28 years as an AFRL T2 manager, was generally well-known throughout the Air Force community that she surveyed. The same was true for Chris Root with the Navy, and Dr. Russ Alexander with the Army. All private-sector executives interviewed were affiliated with companies that TechLink had previously helped to establish license agreements or CRADAs with DoD labs.

To create the survey pool, each of the research team members compiled an initial list of interviewees in his or her respective survey group. The goal was to interview most, if not all, the T2 ORTAs in each DoD service or independent agency, as well as a representative group from each of the other communities (lab S&Es, legal counsel, lab leaders, acquisition program managers, and private-sector executives).

From these initial lists of interviewees, the survey pool gradually grew. The T2 community was interviewed first. One of the final questions posed to each ORTA was who else the TechLink team should interview in their lab's S&E, legal, and lab leadership communities. Frequently, these ORTAs followed up with helpful email introductions. All interviewees were asked if the research team could contact them again if there were follow-up questions.

The TechLink team conducted an **initial round of 165 in-depth interviews**, including 131 with DoD personnel and 34 with company executives. These interviews involved 107 different organizations—73 DoD entities and 34 companies.

As Table 1 shows, the **131 DoD personnel interviewed** included three T2 program management offices (Army, Navy, and Air Force), 14 acquisition programs, and 56 labs. Altogether, these interviews involved the three heads of the T2 program management offices, 17 acquisition program managers; 59 ORTAs; 18 lab S&Es; 18 legal personnel supporting IP and T2; and 16 lab leaders.

See Table 1 on the next page

Table 1. Interviews with DoD Personnel

Interviews with DoD Personnel			
Type of Organization	Number of Organizations Interviewed	Category of Interviewee	Total DoD Interviewees
DoD T2 Management Offices	3	T2 Program Managers	3
DoD Acquisition Programs	14	Program Managers	17
DoD Labs	56		
		Lab T2 Managers (ORTAs)	59
		S&Es	18
		Legal Counsel	18
		Lab Leaders	16
Total	73		131

Broken down by component, the Air Force accounted for 38 of the interviewees, the Army for 40, the Navy for 37, and the independent defense agencies (including DHA, DISA, NSA, STRATCOM, DMEA, SOCOM, and USUHS) for 16 (total of 131).

Table 2 provides a summary of the interviews with DoD labs and companies, broken down by size of the organization. The 56 DoD labs included in the interviews varied greatly in size, with the smallest having only 28 S&Es and the largest over 10,000 S&Es.

As the table shows, these interviews involved seven very large labs, with at least 5,000 S&Es; 22 large labs, with between 1,000 and 4,999 S&Es; nine medium-sized labs with 500 to 999 S&Es; 12 small labs with between 100 and 499 S&Es; and six very small labs, with 28 to 99 S&Es. Of the 111 total DoD lab personnel interviewed, very large labs accounted for 17 of these personnel; large labs for 47; medium-sized labs for 16; small labs for 24; and very small labs for six.

The 34 private-sector interviews included eight with large corporations (more than 500 employees) consisting of a mix of Fortune 500 companies and major defense contractors. Also included were three *medium-sized* companies (100-499 employees), 11 *small* companies (10-99 employees), and 12 *very small* companies (fewer than 10 employees). This breakdown roughly corresponds to the sizes of the companies participating in DoD T2. For example, in the 2022 economic impact study (EIS) of DoD license agreements conducted by TechLink, large companies comprised 17% of the DoD licensees; medium-sized companies, 8%; small companies, 31%; and very small companies, 45% (TechLink 2022).

See Table 2 on the next page

Table 2. Interviews by Size of DoD Lab or Company

Interviews by Size of DoD Lab or Company			
Type	**Size of Organization**	**Number of Organizations interviewed**	**Total Interviewees**
DoD Labs	Very Large (5,000+ S&Es)	7	17
	Large (1,000-4,999 S&Es)	22	47
	Medium-sized (500-999 S&Es)	9	16
	Small (100-499 S&Es)	12	24
	Very Small (28-99 S&Es)	6	7
	Subtotal	56	111
Companies	Large (> 500 employees)	8	8
	Medium-sized (100-499 employees)	3	3
	Small (10-99 employees)	11	11
	Very Small (1-9 employees)	12	12
	Subtotal	34	34
Total		90	145

Responses to the interview questions were first compiled in a centralized Excel database, with a different spreadsheet for each category of interviewee: T2 community, legal counsel, S&Es, lab leadership, acquisition community, and private sector. Next, the “yes” and “no” answers were statistically analyzed, and the qualitative or descriptive responses were “open coded” into common themes or primary concepts.

For example, when asked how they defined T2 success, virtually every T2 program manager or ORTA gave a different explanation. Some explanations were similar, some very different. In addition, some of the answers included several different concepts of success. Upon close analysis, however, common themes emerged. Out of the 62 T2 personnel interviewed (three T2 program managers and 59 ORTAs), 32 included in their responses some version of the following primary concept: “Delivering impactful new technology to the U.S. Warfighter.” The TechLink team carefully reviewed the responses to discern and categorize the common themes or concepts. Overall, the question of how DoD T2 managers defined success elicited 15 unique primary concepts.

The coded interview results were subsequently summarized, with a different summary for each category of interviewee—T2 managers, lab S&Es, legal staff supporting IP protection and T2, lab leaders, the acquisition community, and the private sector. In addition, the recommendations for improvement of the

DoD T2 system were extracted from the interview notes and separately compiled, organized, and analyzed. This analysis generated questions for follow-up interviews.

TechLink conducted **35 follow-up interviews**, for a total of 200 interviews—160 with DoD personnel and 40 with DoD's private-sector T2 partners. These follow-up interviews had two distinct purposes: (1) to probe more deeply into certain initial interview comments that seemed insightful or important, but which time constraints did not permit the TechLink team to adequately explore at that time; and (2) to elicit feedback on proposed ideas or recommendations to improve DoD's T2 system. Responses from the follow-up interviews were integrated with the initial survey results using the methodology described above. All coded Task 2 interview results were carefully checked for accuracy.

Summary of Results

Major findings from the Task 2 interviews are summarized below. (The complete coded interview results are presented in Appendix 6). These results are organized according to the interviewee category and are presented in the following order: DoD T2 managers (T2 Program Managers and ORTAs), lab S&Es, legal staff, lab leaders, the DoD acquisition community, and the private sector.

The percentages listed indicate the number of individuals providing that primary concept in their responses. The total percentages of the qualitative responses exceed 100% because some of the responses included multiple primary concepts. For example, an interviewee may have provided a multi-faceted definition of T2 success that included (1) "Delivering impactful new technology to the U.S. Warfighter"; (2) "Achieving mutual success for both DoD and its private-sector partners"; and (3) "Getting DoD lab inventions out the door and commercialized in a timely way."

DoD T2 Managers (62 total)

DoD T2 managers' definitions of T2 success included the following:

- 52%: Delivering impactful new technology to the U.S. Warfighter
- 31%: Achieving mutual success for both DoD and its private-sector partners
- 29%: Getting DoD lab inventions out the door and commercialized in a timely way
- 15%: Achieving relatively high numbers of T2 agreements and other traditional metrics
- 8%: Benefiting the U.S. economy and providing a better ROI to the U.S. taxpayer from federal R&D dollars
- 8%: Effectively supporting the lab's S&Es
- 7%: Achieving a culture within DoD that highly values T2 and understands how it supports the defense mission
- 7%: Generating success stories of how DoD T2 benefits the American public
- 15%: Something else, each mentioned by one or two T2 managers

Does your lab have established and documented T2 processes?

T2 Manager Responses:

- 54%: Yes, but only limited or partially developed T2 procedures
- 41%: Yes, fully developed procedures and processes
- 5%: No, but they are currently developing them

Do you have the resources and support you need to be successful in T2?

T2 Manager Responses:

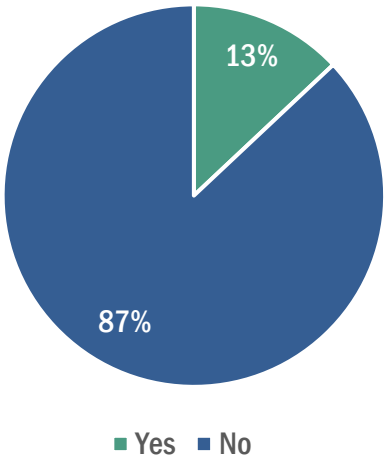


Figure 2.

T2 Manager Responses to the Question: *Do you have the resources and support you need to be successful in T2?*

87% of the DoD T2 managers interviewed said they *lacked* the resources and support needed to be successful in their positions:

- 61%: Not enough personnel assigned to T2
- 55%: Inadequate budget for T2 function
- 53%: Insufficient T2 training
- 42%: Lack of reporting of new inventions in their lab
- 40%: Inadequate or ineffective IP or legal support
- 31%: S&Es not cooperative
- 31%: Lack of support from lab leadership
- 18%: Something else

DoD T2 managers recommended the following to address their lack of resources and support:

- 34%: Provide more staff for T2 function, including more legal staff for IP protection and review of T2 agreements
- 34%: Provide more T2 education and training for S&Es and lab leadership on how T2 serves and benefits the defense mission, and include T2 as a measure of performance on their annual reviews
- 27%: Provide more baseline funding for T2 function
- 23%: Increase and improve T2 training for ORTAs
- 35%: Something else, each recommended by one or two T2 managers

If you had enough resources and support, would your lab be significantly more successful with T2?

T2 Manager Responses:

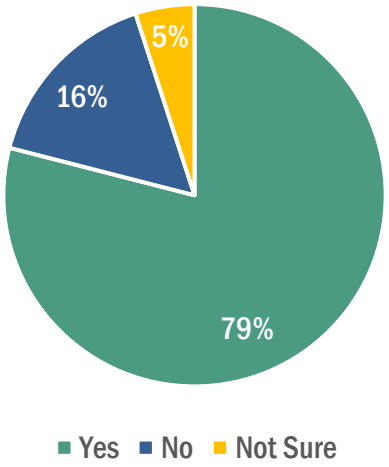


Figure 3.

T2 Manager Responses to the Question: *If you had enough resources and support, would your lab be significantly more successful with T2?*

What metrics do you currently use to measure your lab's T2 success?

T2 Manager Responses:

- 47%: Just the metrics we're required to report annually
- 13%: Examples of T2 successes and impacts, in addition to the required annual metrics
- 10%: Increases in numbers of T2 metrics, in addition to the required annual metrics
- 6%: Impact on the defense mission, in addition to the required annual metrics
- 5%: Time to complete T2 agreements, in addition to the required annual metrics
- 19%: Something else, each mentioned by one or two T2 managers

Do you think these metrics could be improved?

T2 Manager Responses:

- 76%: Yes
- 13%: No
- 11%: Not sure

DoD T2 managers' suggestions for improving DoD's T2 metrics:

- 18%: Assess the quality of T2 outcomes as opposed to measuring T2 activities
- 13%: Measure the downstream outcomes and impacts from T2
- 13%: Measure T2's impact on the defense mission
- 8%: Standardize T2 metrics across the DoD enterprise
- 5%: Measure the time it takes to execute T2 agreements
- 5%: Measure improvements to DoD lab technologies that result from T2 agreements
- 27%: Something else, each mentioned by one or two T2 managers

Do you consistently provide training to S&Es in IP protection and T2?

T2 Manager Responses:

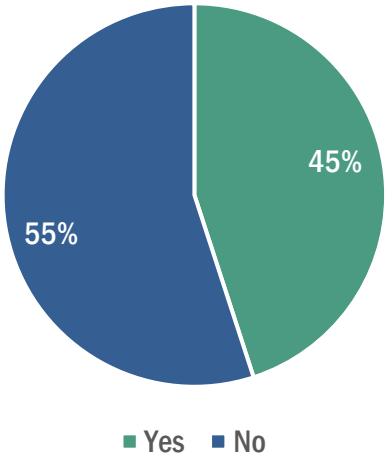


Figure 4.

T2 Manager Responses to the Question: *Do you consistently provide training to S&Es in IP protection and T2?*

What do you see as the main purpose or value of technology transfer for DoD?

T2 Manager Responses:

- 85%: To support the U.S. defense mission by leveraging the ingenuity, resources, and capabilities of the private sector
- 27%: To strengthen the defense mission and national economy
- 19%: To increase the ROI to the U.S. taxpayer
- 8%: To leverage the capabilities of university researchers
- 6%: Something else, each mentioned by one or two T2 managers

Responses to the question: Do you think DoD T2 is effective in supporting the defense mission?

- 79%: Yes
- 16%: No
- 5%: Not sure

Suggestions for changing DoD T2 processes to better support the defense mission:

- 21%: Educate lab leaders on how T2 supports the defense mission and motivate them to support T2 by including T2 metrics in their performance evaluations
- 19%: Streamline and accelerate T2 processes
- 16%: Strengthen the links between T2 and DoD acquisition and end users
- 16%: Implement changes in DoD policy and instructions
- 15%: Provide an adequate budget for the T2 function
- 8%: Increase the T2 focus on spinning in of private-sector technology to address critical DoD technology needs
- 8%: Make T2 training mandatory for all lab personnel
- 6%: Establish a "technology pull" system that starts with DoD requirements
- 6%: Establish better outreach to non-traditional companies, emphasizing the benefits of T2
- 5%: Customize T2 training for DoD, emphasizing how T2 tools can be effectively used to support the defense mission
- 18%: Something else, each mentioned by one or two T2 managers

82% of the DoD T2 managers interviewed said that metrics could be established to measure T2's impacts on the defense mission, suggesting the following metrics:

- 48%: Transition to DoD operational use
- 28%: Increases in Warfighter capabilities
- 22%: Success stories of impacts on the defense mission
- 10%: Cost savings and cost avoidance

DoD Scientists and Engineers (S&Es) (18 total)

Is it important for your lab to patent its inventions and transfer these inventions to the private sector?

S&E Responses:

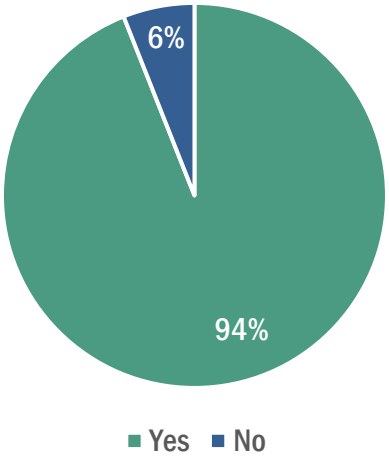


Figure 5.

S&E Responses to the Question: *Is it important for your lab to patent its inventions and transfer these inventions to the private sector?*

Reasons given by S&Es for why patenting and transferring lab inventions is important:

- 41%: To protect DoD's intellectual property
- 29%: To enable the private sector to develop military products to support the defense mission
- 24%: To benefit the U.S. economy and American public
- 18%: To provide career-enhancing recognition for the lab's inventors
- 41%: Something else, each mentioned by one or two S&Es

Have you encountered any problems in participating in the IP protection or T2 process?

S&E Responses:

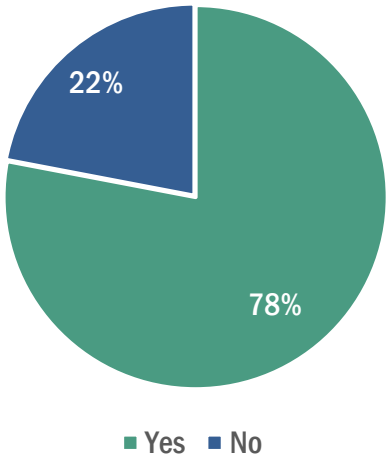


Figure 6.

S&E Responses to the Question: *Have you encountered any problems in participating in the IP protection or T2 process?*

78% of the S&Es stated that they had encountered various problems in IP protection and/or technology transfer:

- 44%: They lacked the time to write invention disclosures or interact with industry
- 39%: The necessary support from the legal office was lacking
- 39%: They did not have a budget to which to charge time for this activity
- 33%: Their branch or division chiefs didn't think these activities were important
- 28%: These activities were not important for career advancement
- 22%: They didn't understand the process
- 28%: Something else

S&E recommendations on how to overcome the problems identified:

- 33%: Fully educate lab leaders on how IP protection and T2 support the defense mission and incentivize them to strongly support these activities
- 17%: Provide an overhead charge code to S&Es to enable them to charge time spent on IP protection and participation in the T2 process
- 17%: Provide adequate legal staff to support the IP protection and T2 function
- 17%: Provide a sustained adequate budget for the T2 function
- 11%: Incentivize S&Es to care about whether their technology transitions
- 56%: Something else, each mentioned by one or two S&Es

Could your lab's R&D goals and metrics be improved to better support the defense mission?

S&E Responses:

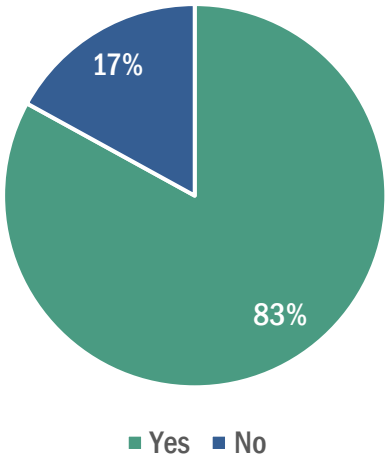


Figure 7.

S&E Responses to the Question: *Could your lab's R&D goals and metrics be improved to better support the defense mission?*

83% of S&Es said their lab's R&D goals and metrics could be improved to better support the defense mission. Suggestions offered included:

- 28%: Provide more sustained support for DoD's R&D efforts to ensure that promising inventions become fully developed and transitioned to the Warfighter
- 17%: Evaluate lab leadership on the extent to which lab-developed technologies are supporting the defense mission
- 11%: Provide significant recognition for S&Es whose new technologies are supporting the defense mission
- 11%: Measure whether lab-developed technologies transition to programs of record
- 11%: Establish stronger connections with the acquisition community so they are aware of the lab's new mission-relevant technologies
- 28%: Something else, each mentioned by an individual S&E

How could your lab's T2 activities be improved to better support the defense mission?

S&E Responses:

- 22%: By adequately funding S&Es to participate in T2 and technology transition activities
- 17%: Through providing better T2 training for S&Es
- 17%: By adopting standardized and streamlined T2 templates across DoD
- 11%: By the T2 office becoming more proactive in finding outside T2 partners
- 11%: By educating all lab employees, from top to bottom, on the value of T2 and what it can accomplish
- 11%: By incentivizing lab leadership to support T2 more strongly
- 17%: Something else, each mentioned by an individual S&E

Legal Counsel (18 total)

What do you see as the main purpose or value of protecting DoD inventions and other IP?

Legal Counsel Responses:

- 50%: To prevent DoD contractors from claiming the invention and charging DoD for it
- 44%: To enable DoD lab inventions to be transferred to industry to support the U.S. Warfighter
- 28%: To enable DoD lab inventions to be transferred to industry to benefit the U.S. economy and American public
- 22%: To protect the U.S. government from patent infringement claims
- 17%: Patents are good evidence of lab productivity and value
- 17%: Patenting inventions provides recognition for lab S&Es
- 6%: To give the U.S. government the freedom to practice the invention

Do you have the resources and support that you need to adequately protect DoD's inventions and other intellectual property?

Legal Counsel Responses:

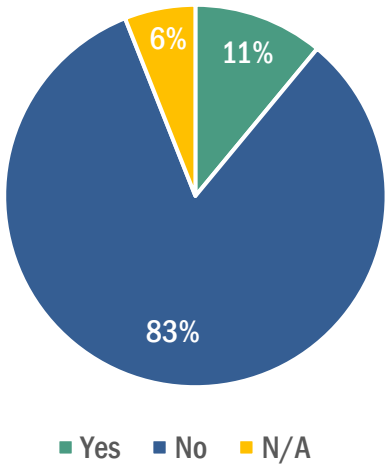


Figure 8.

Legal Counsel Responses to the Question: *Do you have the resources and support that you need to adequately protect DoD's inventions and other intellectual property?*

83% of the lawyers said they lacked the necessary resources and support for effective IP protection and T2:

- 61%: Lack of knowledge of new inventions in the lab
- 56%: Inadequate budget for patenting and IP protection
- 50%: Not enough personnel assigned to their office
- 33%: Poor support from the T2 office
- 33%: Lack of support from lab leadership
- 33%: Lack of cooperation from lab S&Es
- 22%: Too many other responsibilities
- 17%: Something else

Lawyers interviewed recommended the following to address their lack of resources and support for IP protection and T2:

- 28%: Establish a larger, more stable budget for IP protection and legal support for T2
- 17%: Motivate DoD leadership to prioritize IP protection and T2 in support of the defense mission
- 17%: Establish better coordination on IP protection between different labs and programs
- 17%: Increase the number of legal personnel dedicated to IP protection and T2 support
- 11%: Give the T2 office more personnel and authority
- 11%: Incentivize S&Es to engage in IP protection and T2 through including these activities in their performance reviews
- 11%: Establish a centralized IP management database
- 44%: Something else, each mentioned by one individual

Does your lab have an invention evaluation board or committee?

Legal Counsel Responses:

- 44%: Yes
- 39%: No
- 17%: Not sure or no response

Do you believe your lab's S&Es are disclosing most of their inventions?

Legal Counsel Responses:

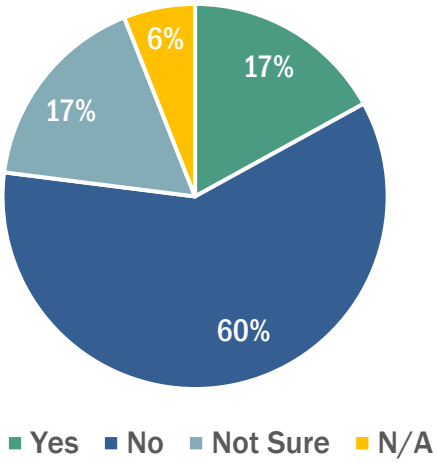


Figure 9.

Legal Counsel Responses to the Question: *Do you believe your lab's S&Es are disclosing most of their inventions?*

Do you consistently provide training to your lab's S&Es in IP protection and assist them with invention disclosures?

Legal Counsel Responses:

- 61%: Yes
- 33%: No
- 6%: No response

What metrics do you currently use to measure your office's success in protecting DoD inventions and IP?

Legal Counsel Responses:

- 44%: Number of patent applications
- 44%: Number of issued patents
- 33%: We have no specific metrics
- 22%: Number of invention disclosures
- 17%: Number of patent applications that result in issued patents
- 11%: How long it takes to complete different IP tasks
- 22%: Something else, each mentioned by one individual

67% of the lawyers interviewed thought these metrics could be improved and provided the following recommendations:

- 33%: Measure the percentage of patents that are licensed by industry
- 25%: Prioritize the quality of patents rather than the number of patents
- 17%: Develop an effective, user-friendly IP management system
- 17%: Measure the impact of DoD lab technologies on the defense mission or U.S. economy
- 17%: Measure the ratio of the number of invention disclosures to the number of issued patents
- 28%: Something else, each mentioned by one individual

Lab Leadership (16 total)

What do you see as the main purpose of protecting lab inventions and transferring them to industry?

Lab Leadership Responses:

- 31%: Gets DoD inventions into production so DoD can procure them to benefit the U.S. Warfighter
- 25%: Leverages private-sector capabilities, resources, and ingenuity for commercialization of dual-use technologies
- 25%: Keeps DoD from having to pay twice for the inventions, which could occur if DoD doesn't patent its inventions and someone else does
- 25%: Engages industry to help support the defense mission
- 19%: Benefits the U.S. economy and provides a better return on investment to the American taxpayer
- 13%: Creates an opportunity to recognize and reward the inventors
- 13%: Allows the government to control the dissemination of its inventions to ensure the maximum social or military benefit
- 19%: Something else, each mentioned by a single lab leader

Do you think your S&Es are doing an adequate job of disclosing their inventions?

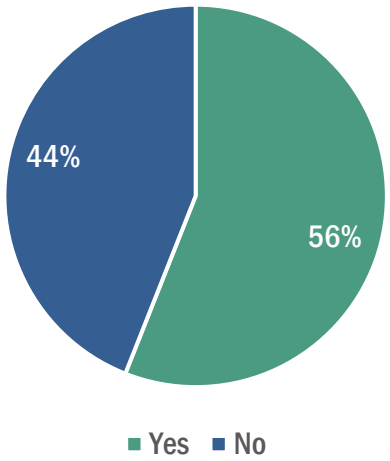


Figure 10.

Lab Leader Responses to the Question: *Do you think your S&Es are doing an adequate job of disclosing their inventions?*

How would you suggest motivating S&Es to do a better job of disclosing their inventions?

Lab Leadership Responses:

- 53%: Reward S&Es for invention disclosures and issued patents
- 53%: Provide better training to S&Es on the importance of IP protection and T2 to the defense mission
- 20%: Make it easy for S&Es to disclose their inventions by providing substantial assistance
- 13%: Make S&Es aware that they will receive a substantial portion of any licensing revenues
- 44%: Something else, each mentioned by a single lab leader

Do you view transferring your lab's inventions to industry as a legal obligation or DoD requirement?

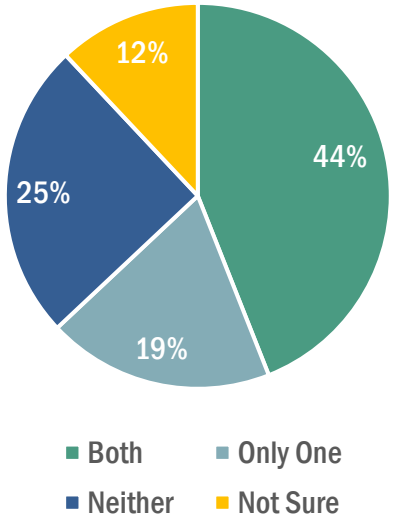


Figure 11.

Lab Leader Responses to the Question: *Do you view transferring your lab's inventions to industry as a legal obligation or DoD requirement?*

94% of lab leaders viewed CRADAs with industry and universities as important for their labs, and gave the following reasons:

- 67%: They enable us to leverage the expertise and resources of the outside innovation ecosystem to develop new technology for the defense mission
- 13%: They enable us to conduct collaborative R&D with outside entities in a legally protected environment
- 13%: They enable us to evaluate outside technologies for U.S. military application
- 13%: They help advance knowledge within the lab's S&E community
- 7%: They allow us to cover the use of lab equipment without liability

Do you ever interact with acquisition programs to make them aware of new technologies your lab has developed? *Lab Leadership Responses to the Question:*

- 63%: Yes
- 38%: No

Are you incentivized in your performance reviews to try to transition your lab's new technologies to the Warfighter?

Lab Leader Responses:

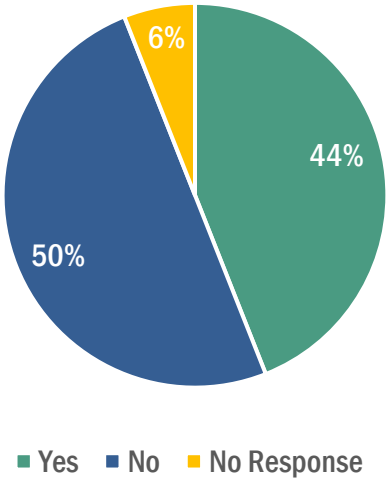


Figure 12.

Lab Leader Responses to the Question: *Are you incentivized in your performance reviews to try to transition your lab's new technologies to the Warfighter?*

Problems cited by lab leaders in getting their lab's new technologies into DoD acquisition programs:

- 75%: The acquisition community does not seem receptive
- 63%: The Federal Acquisition Regulation (FAR) seems to discourage technology transition from DoD labs
- 56%: Lack of a clearly defined process
- 56%: The T2 process is too slow or ineffective
- 19%: Something else

Lab leaders' recommendations for fixing the above problems:

- 19%: Require the DoD acquisition and S&T communities to work more closely together and coordinate funding for technology transition
- 19%: Establish more effective mechanisms to enable rapid procurement of new technology
- 19%: Require the acquisition community to receive training in how DoD T2 supports the defense mission and how to transition lab technologies to acquisition programs
- 75%: Other recommendations, each provided by a single lab leader

Could your lab's R&D goals and metrics be improved to better support the defense mission?

Lab Leadership Responses to the Question:

- 88%: Yes
- 12%: No

What could DoD do to enable DoD labs to have a bigger impact on the defense mission?

Lab Leadership Responses:

- 19%: Do a better job of tracking the impacts of DoD lab technologies on the defense mission
- 19%: Provide more funding and resources (including greater support for PIAs) to enable transitioning DoD lab inventions to DoD operational use
- 13%: Streamline processes to get DoD lab technologies transferred and transitioned more rapidly
- 13%: Do a better job of integrating lab R&D activities with Warfighter needs
- 13%: Give S&Es flexibility to pursue their defense mission-related ideas
- 81%: Other recommendations, each provided by a single lab leader

How important is T2 in transitioning your lab's inventions into acquisition programs?

Lab Leader Responses:

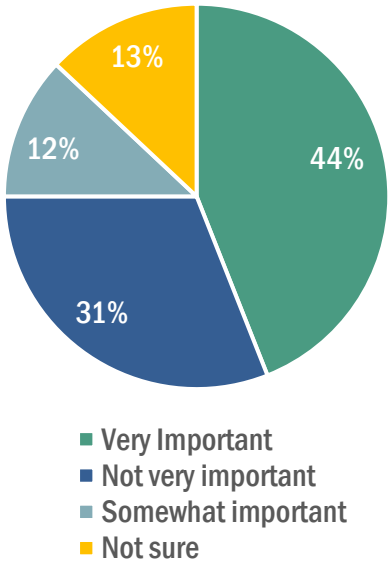


Figure 13.

Lab Leader Responses to the Question: *How important is T2 in transitioning your lab's inventions into acquisition programs?*

How could DoD make T2 more effective at supporting the defense mission?

Lab Leadership Responses:

- 19%: Give priority to T2 activities that support the defense mission
- 13%: Increase funding to enable DoD to expand evaluation of new private-sector innovations for DoD application
- 13%: Establish a centralized database to provide visibility of its entire patent portfolio at the service or DoD enterprise level
- 63%: Other recommendations, each provided by a single lab leader

DoD Acquisition Community (17 total)

How important is the DoD laboratory system in generating new technologies for acquisition programs and Warfighter use?

Acquisition Community Responses:

- 81%: Important for generating new defense-related technologies and solutions for the Warfighter
- 25%: Not very important in generating new technologies for our acquisition programs
- 6%: Less important than industry in generating new technologies for our acquisition programs
- 6%: Important because labs have closer contacts with technology advances in industry than the acquisition community does

Does T2 play an important role in transitioning DoD lab inventions into DoD operational use?

Acquisition Community Responses:

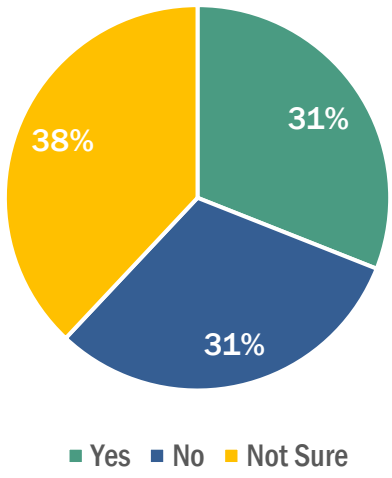


Figure 14.

Acquisition Community Responses to the Question: *Does T2 play an important role in transitioning DoD lab inventions into DoD operational use?*

94% of the acquisition personnel interviewed thought the role of T2 in supporting the defense mission could be increased or improved and offered the following recommendations:

- 19%: Change the system so acquisition programs give greater priority to acquiring technology from companies that have either licensed DoD lab technologies or co-developed new technologies with DoD labs
- 13%: Provide better education and training to acquisition program and project managers on the strengths and advantages of using T2 mechanisms to support the defense mission
- 13%: Provide financial incentives to the private sector to engage in T2 agreements to develop dual-use technology that DoD can procure
- 13%: Provide more funding to DoD labs to advance the technology readiness level (TRL) of promising DoD lab technologies and get them through the "valley of death"
- 74%: Other recommendations, each provided by a single acquisition program individual

Problems cited by acquisition personnel in getting new DoD lab technologies into DoD acquisition programs:

- 69%: Lack of a clearly defined process
- 44%: The FAR seems to discourage technology transition from DoD labs
- 44%: The T2 process is too slow or ineffective
- 25%: The labs do not seem to be interested or receptive
- 69%: Something else

Acquisition personnel's recommendations to fix the above problems:

- 13%: Establish better alignment of R&D projects and acquisition program needs through increased communications, to enable greater transition of DoD lab technologies
- 13%: Establish early and regular interactions between DoD labs and acquisition programs to encourage more transition from the labs
- 13%: Improve and standardize Technology Transition Agreements (TTAs) across DoD
- 50%: Other recommendations provided by single acquisition community individuals

Are you incentivized in your performance reviews to transition DoD lab inventions into acquisition programs?

Acquisition Community Responses:

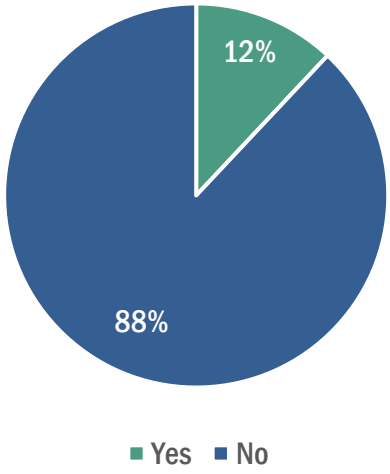


Figure 15.

Acquisition Community Responses to the Question: *Are you incentivized in your performance reviews to transition DoD lab inventions into acquisition programs?*

81% of the acquisition community interviewees stated that DoD's R&D goals and metrics could be improved to better support the defense mission, and offered the following recommendations:

- 46%: Incentivize personnel to transition DoD lab technologies to acquisition programs by including this activity in their performance reviews
- 23%: Place greater emphasis on achieving an impact on the defense mission when creating R&D goals and metrics
- 15%: Document the many technology transitions that are occurring through T2 and support agreements using DD Form 1144, which would encourage better alignment between DoD's R&D goals and metrics in support of the defense mission
- 32%: Other recommendations provided by single acquisition community individuals

100% of the acquisition community interviewees stated that DoD's acquisition program could be improved to better support the transition of DoD lab-developed technology and offered the following recommendations:

- 19%: Establish frequent and regular mechanisms for DoD labs to communicate their new technology developments with acquisition program managers
- 13%: Establish an investment roadmap for DoD lab technology transfer and transition
- 13%: Better align DoD lab R&D goals with acquisition programs
- 13%: Provide better education to DoD lab personnel on how the DoD acquisition process works
- 68%: Other recommendations provided by single acquisition community individuals

Private Sector (34 total)

How did you learn about the opportunity to engage with the Department of Defense through a license agreement or CRADA?

Private Sector Responses:

- 26%: Through the lab's S&Es
- 26%: Through a previous relationship with DoD or the lab
- 24%: Through TechLink
- 12%: Through the lab's T2 office
- 15%: Other, mentioned by one or two individuals

Was establishing a T2 agreement with DoD a smooth and timely process?

Private Sector Responses:

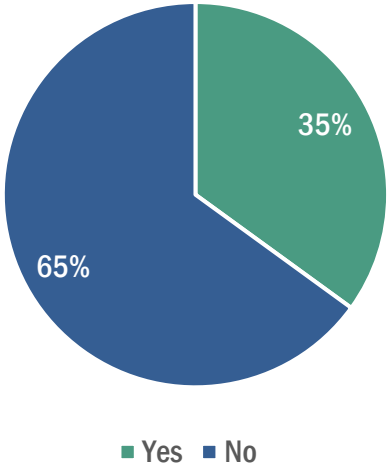


Figure 16.

Private Sector Responses to the Question: Was establishing a T2 *agreement with DoD a smooth and timely process?*

65% of DoD private-sector T2 partners said that establishing the agreement was not a smooth and timely process, citing the following problems:

- 74%: It was difficult to figure out the process
- 50%: It took too long to establish the agreement
- 47%: The process seemed too bureaucratic
- 38%: The terms were not favorable to the company
- 24%: The lab's T2 personnel were not very helpful
- 21%: The lab's lawyers were difficult to work with
- 24%: Something else

How would you recommend that DoD fix the problem(s) you just identified?

Private Sector Responses:

- 32%: DoD needs to standardize and streamline its T2 processes, so they are more readily understood and easier to follow
- 18%: DoD labs need to develop stronger connections with the acquisition community and end users to help pave the way to transition
- 12%: T2 personnel need to be given business and entrepreneurship training and education so they understand private-sector needs and perspectives
- 12%: DoD needs to recognize T2 as an essential part of the defense mission and give greater priority to T2
- 12%: DoD needs to make it easier for DoD licensees or CRADA partners to transition new dual-use technologies or products to DoD acquisition programs
- 9%: In cases where licensed DoD lab technologies meet critical military needs, DoD needs to provide support to licensees after the agreements are signed to facilitate successful transition
- 50%: Something else, each mentioned by a single private-sector executive

If you had a license agreement, what was the main value to your company of licensing government-developed technology?

Private Sector Responses:

- 43%: Time and money savings in the R&D and product development process
- 43%: Licensing from DoD opened the door to U.S. military sales
- 29%: The licensed technology enabled us to develop a successful new product
- 19%: The DoD lab origin of the technology gave a high degree of confidence to our investors and/or customers
- 10%: Leveraging the creativity, expertise, effort, and facilities of DoD's world-class research enterprise
- 5%: R&D risk reduction by acquiring a technology that had already been patented and reduced to practice

67% of the executives of companies with DoD license agreements said that there were downsides to licensing from the government, including:

- 29%: We experienced difficulties selling the licensed technology to DoD, despite their need for this technology
- 14%: Venture capital firms don't like some of the clauses in standard license agreements, such as government use and march-in rights and U.S manufacture requirements
- 14%: It was difficult to change the terms of the license agreement later, based on our experience developing the technology and evolving market conditions
- 14%: The DoD lab wouldn't allow access to the inventor for follow-up questions after the license agreement was signed
- 14%: The lab would not give us an exclusive license to the technology, even though we are a Fortune 500 company and had a compelling need for an exclusive license
- 50%: Something else, each mentioned by a single private-sector executive

If you had a CRADA, what were the advantages of collaborating with a DoD lab under that mechanism?

Private Sector Responses:

- 27%: The collaboration helped us be more successful in our R&D project
- 27%: Gaining access to unique expertise and research facilities
- 15%: The CRADA project opened the door to U.S. military sales
- 15%: Continuing access to the inventors to help successfully commercialize the technology
- 12%: The CRADA allowed us to share IP and information with the DoD under a legally protected environment
- 12%: Developing an ongoing strong relationship with the DoD S&Es
- 8%: This collaboration with the DoD lab made us more confident in proceeding with our R&D project
- 8%: This collaboration with the DoD lab enabled us to establish credibility with other government labs and customers
- 8%: This collaboration helped us to understand the DoD marketplace for new technology
- 12%: Something else, each mentioned by a single private-sector executive

58% of the executives of companies with CRADAs said that there were downsides to collaborating with DoD under a CRADA, including:

- 33%: The DoD S&Es were not very responsive or cooperative
- 20%: We experienced difficulties selling the CRADA-developed technology to DoD, despite their need for this technology
- 20%: The CRADA took far too long to establish
- 13%: The CRADA project cost us a lot more than the amount listed in the CRADA
- 27%: Something else, each mentioned by a single private-sector executive

Despite problems you may have previously encountered, would you be willing to enter into future CRADAs or license agreements with DoD?

Private Sector Responses:

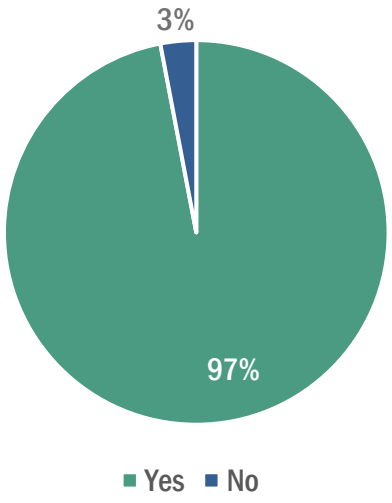


Figure 17.

Private Sector Responses to the Question: *Despite problems you may have previously encountered, would you be willing to enter into future CRADAs or license agreements with DoD*?

Task 3: Develop Logic Model of the Current DoD T2 System

Develop a logic model of the current DoD T2 system—focusing on inputs, activities, outputs, outcomes, and impacts—to provide a comprehensive view of how this system functions and help detect shortcomings and areas for improvement.

Methodology

A logic model is a framework for program assessment that is frequently used in the public, private, and non-profit sectors. The concept dates to the 1960s (McLaughlin and Jordan 2004). However, in the 1970s, Wholey pioneered the use of this concept for program evaluation and was the first social scientist to use the term "logic model" (Wholey 1979).

According to Wholey, logic models graphically convey the structure of a program by deconstructing it into its logical elements—the inputs, activities, outputs, outcomes, and impacts. This helps program managers understand the causal relationships between these key elements and improve how they design and manage their programs. Wholey also viewed logic models as a useful device for reducing large amounts of data to a form that "can be assimilated and used as a frame of reference for discussions about the program" (Wholey 1979, p. 60).

Logic models began to become widely used with enactment of the Government Performance and Results Act (GPRA) in 1993. This legislation tasked federal agencies and federally funded programs with providing greater accountability, essentially asking three basic questions: *What is this program trying to achieve? How will you measure its effectiveness? How is it actually doing?* (McLaughlin and Jordan 1999). Logic models were subsequently adopted by many program managers to address GPRA requirements and help justify their programs.

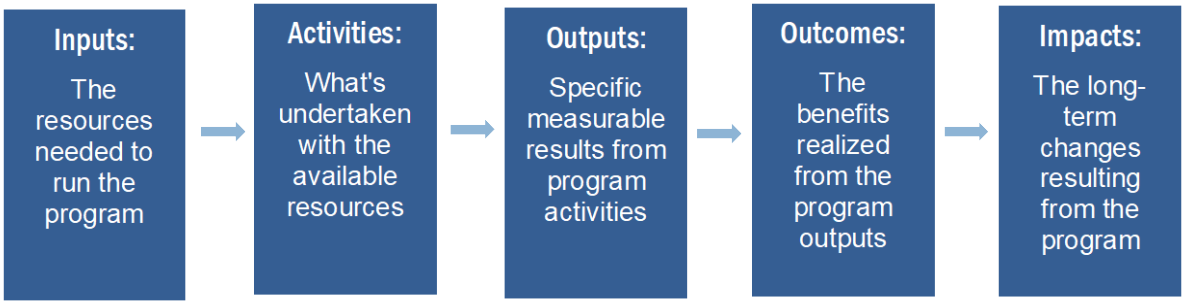


Figure 18. Generic Logic Model of a Hypothetical Program

Figure 18 depicts a generic logic model. It demonstrates how any program can be rationally broken down into its key elements—the inputs, activities, outputs, outcomes, and impacts. *Inputs* are the resources needed to operate a program, such as personnel and funding. Depending on the program, inputs also might include policy documents, program guidelines, oversight boards, staff training, partnerships with other

organizations, and many other factors. *Activities* are the actions undertaken with the program resources, such as actions to assist a specific segment of society. *Outputs* are the quantifiable results or metrics from the program activities, such as the number of workshops presented or clients assisted. *Outcomes* are the beneficial achievements from the program activities and outputs. They represent the rationale for the program and its intended purpose. Finally, the *impacts* are the desired longer-term changes that the program is trying to effect, such as to achieve some type of improvement in the target population's behavior or socio-economic conditions.

In developing a logic model of the current DoD T2 system, TechLink was guided by the RAND Corporation's study of how logic models could be used to analyze DoD's T2 operations (Landree and Silberglitt 2018). The RAND study described how logic models could "help DoD monitor and track technology transfer from laboratories to customers and assess the success of efforts that may lead to capability improvements" (Landree and Silberglitt 2018, p. 1).

To undertake Task 3, the TechLink team first analyzed the basic elements of an idealized DoD T2 system—the inputs, activities, outputs, intermediate outcomes, end outcomes, and impacts—identifying the essential ingredients for each element. This activity was informed by the TechLink team's longstanding engagement with DoD T2 as well as information and insights from the literature review and in-depth interviews.

To develop a logic model of the current DoD T2 system, TechLink first analyzed the basic elements of an idealized DoD T2 system, identifying the essential ingredients for each of its key elements.

Next, the TechLink team examined the current DoD T2 system, drawing particularly on findings from the Task 2 interviews. Each element in the current T2 system was compared to that in the idealized DoD T2 system. This enabled the TechLink team to diagnose the shortcomings of the current DoD T2 system and construct a logic model portraying these shortcomings. To supplement this model, the TechLink team developed an accompanying one-page graphic that identifies the key deficiencies in each of this system's elements. Collectively, these deficiencies prevent the DoD T2 system from achieving its highest potential.

Summary of Results

This section first summarizes the results from analysis of an idealized DoD T2 system. We examine this system's basic elements and identify the essential ingredients for each of these elements. Next, we present and explain the logic model of the current DoD T2 system. This logic model portrays how this system functions and illuminates its basic shortcomings. Subsequently, we present and discuss the one-page graphic that identifies the key deficiencies in each of this T2 system's elements. The overall purpose is to establish the analytical foundation for development of the logic model of an improved DoD T2 system—the DoD T2 Impact Model.

Basic Elements of an Idealized DoD T2 System

Figure 19 presents the basic elements of an idealized DoD T2 system, summarizing the essential ingredients for each of these elements. As this figure shows, the *inputs* into the DoD T2 system form the preconditions for the subsequent *activities*, and they either enable or constrain the success of those activities. The activities enable the *outputs*, which in turn enable the *intermediate* and *end outcomes*. Finally, the *impacts* stem directly from the end outcomes.

See Figure 19 on the next page

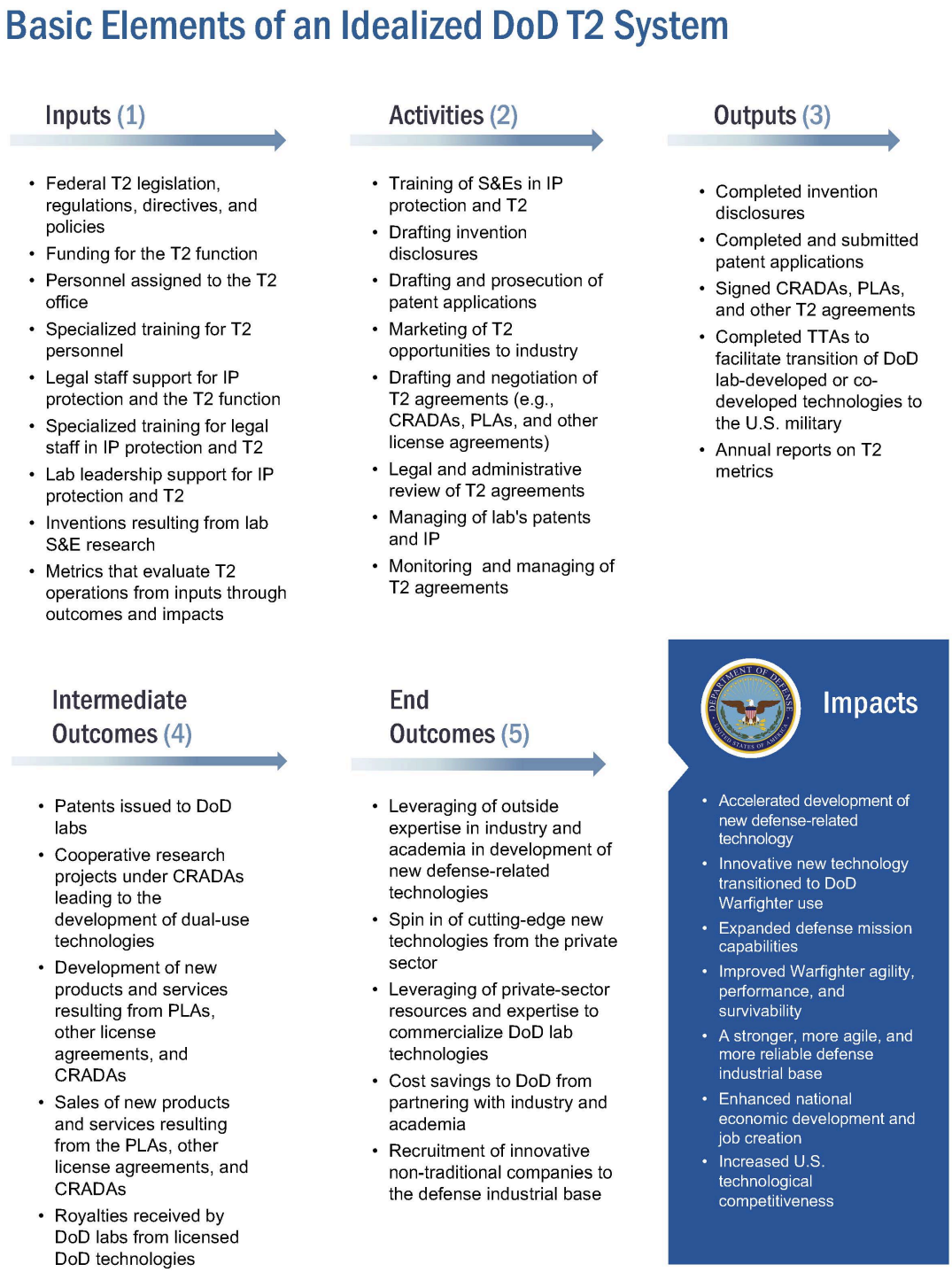


Figure 19. Basic Elements of an Idealized DoD T2 System

As Figure 19 shows, the **Inputs** element of the idealized DoD T2 system includes, at a minimum, the legislation, regulations, directives, and policies that establish the operational framework for DoD T2. The inputs also must include funding for the T2 function, personnel assigned to the T2 office, legal staff to support IP protection and T2 activities, specialized training for both T2 and legal personnel, support from lab leadership, and inventions resulting from the lab's research. Finally, this element must include metrics to evaluate T2 operations from beginning to end—from inputs to impacts.

The essential ingredients of the **Activities** element include training of S&Es in IP protection and T2, so that they become informed and active participants in DoD's T2 enterprise. Essential ingredients also include drafting of invention disclosures; drafting and prosecution of patent applications; marketing of T2 opportunities to industry; drafting and negotiation of licenses, CRADAs, and other T2 agreements; legal and administrative review of these agreements; managing of the lab's patents and other IP; and monitoring and managing of the lab's T2 agreements following their execution.

The essential ingredients of the **Outputs** section include the completed invention disclosures; completed and submitted patent applications; signed PLAs, CRADAs, and other T2 agreements; completed TTAs to facilitate transition of DoD lab-developed or co-developed technologies to the U.S. military; and annual reports on T2 metrics.

Intermediate Outcomes include patents issued to the lab; cooperative research with industry and universities under CRADAs, leading to the development of dual-use technologies; development of new products and services resulting from the license agreements and CRADAs; sales of these products and services; and royalties received by the lab from license agreements.

The **End Outcomes** element of the idealized DoD T2 system includes the desired results, such as DoD's harnessing of outside expertise in academia and industry to develop and commercialize new defense-related technologies; "spin-in" of cutting-edge new technologies from the private sector; cost savings from tapping the resources and expertise of outside entities; and strengthening of DoD's capabilities from recruitment of innovative non-traditional companies to the defense industrial base through the T2 process.

The **Impacts** element of the idealized DoD T2 system consists of all its contributions to the defense mission and the U.S. economy. These include accelerated development of new defense-related technology through R&D partnerships with academia and industry; innovative new technology transitioned to U.S. military use; enhanced and increased defense mission capabilities; a steady flow of improvements in Warfighter agility, performance, and survivability; an expanded, more robust, responsive, and reliable defense industrial base; enhanced technology-led national economic development; and increased U.S. technological competitiveness.

Outcomes and impacts are often confused. However, they differ in two key ways: (1) While *outcomes* are the achievements resulting from the antecedent activities and outputs in the T2 system, *impacts* are the desired longer-term changes resulting from those outcomes. For example, a possible end outcome from DoD T2 might be an innovative, highly effective wound care product. By contrast, the impacts from this product would be improved wound treatment and increased Warfighter survivability. (2) End outcomes, such as a more effective wound care product, are tangible and objectively measurable. However, the impacts of this product—improved treatment and increased Warfighter survivability—represent more far-reaching longer-term positive changes. These are less tangible and more difficult to assess.

Assessments of the Inputs, Activities, Outputs, and Intermediate Outcomes elements can generally be undertaken using *quantitative* metrics. For example, T2 managers and lab leaders can simply count and

maintain a tally of the numbers of T2 personnel trained, invention disclosures drafted, patent applications submitted, T2 agreements executed, patents issued, and new T2-related products developed. Similarly, the sales of those products and royalties back to the lab can be captured with quantitative metrics. However, assessing the End Outcomes requires a high degree of *qualitative* evaluation, such as descriptions of how new defense-related products resulting from the T2 process expand DoD's military capabilities. Finally, although some aspects of the Impacts element can be measured quantitatively, T2's impacts are best comprehended and evaluated using qualitative descriptions and examples.

Logic Model of the Current DoD T2 System

Development of the logic model of an idealized DoD T2 system provided the foundation for analysis of the current DoD T2 system. This analysis drew on findings from the Task 1 literature review and Task 2 interviews. Each element of the current T2 system—inputs, activities, outputs, intermediate outcomes, end outcomes, and impacts—was compared to its counterpart in the idealized DoD T2 system. This comparison enabled the TechLink team to both diagnose the current DoD T2 system and construct a logic model summarizing its deficiencies.

The research team's interviews revealed major shortcomings in all elements of the current DoD T2 system—shortcomings that cause this system to significantly underachieve its potential to have a major impact on the defense mission and national economy. These shortcomings start with the initial inputs and continue throughout the system to the end outcomes and impacts.

Figure 20 represents the current DoD T2 system and graphically depicts its overall deficiencies. As this figure shows, DoD's T2 system is highly circumscribed in its scope and strategic vision. In fact, this system is usually considered to encompass only the T2 inputs, activities, and outputs taking place within the DoD laboratory system.

The operational environment for DoD T2 is generally considered to extend only as far as the T2 events themselves, such as the execution of a license agreement or completion of a CRADA project. In this regard, DoD T2 reflects the "out-the-door" mentality characterized by Bozeman (2000, 2013), which he claimed was the predominant paradigm in both university and federal agency T2

See Figure 20 on the next page

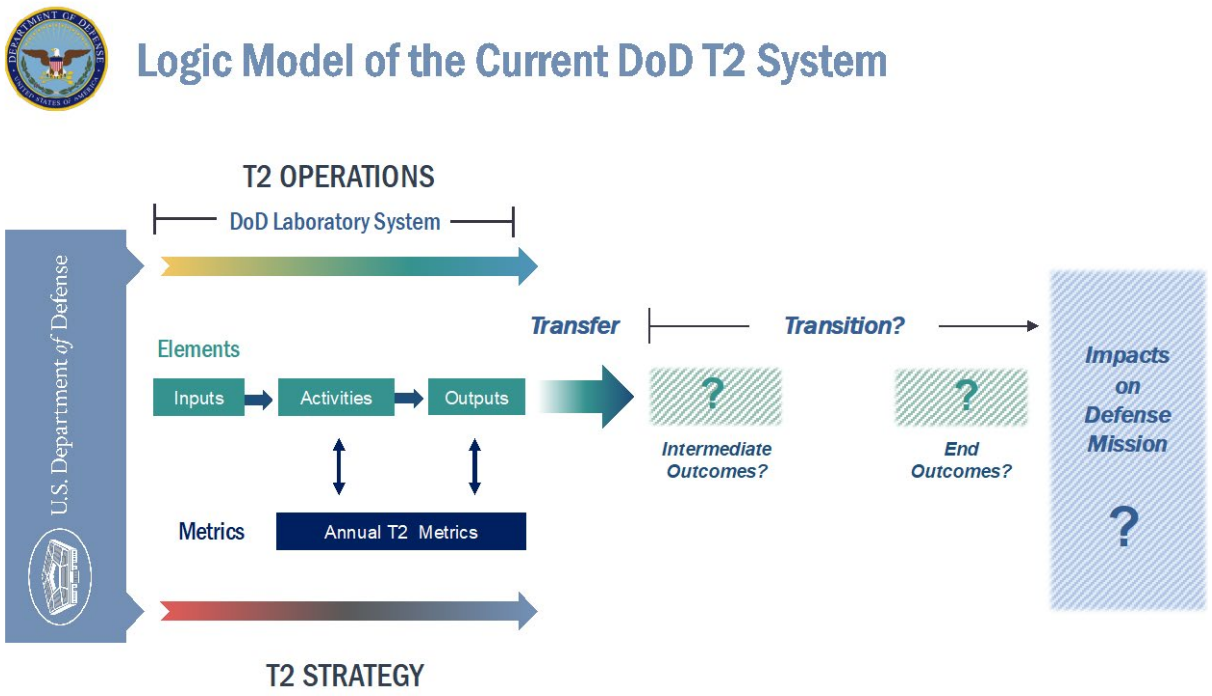


Figure 20. Logic Model of the Current DoD T2 System

In the current DoD T2 system, after T2 agreements are signed, there is almost no follow-up to determine their outcomes and impacts. To illustrate this, the boxes representing the intermediate outcomes, end outcomes, and impacts are punctuated with question marks. What intermediate outcomes resulted from these agreements, such as development of new products that could benefit the U.S. Warfighter? What end outcomes have been achieved, such as new dual-use or military products transitioned to DoD operational use? What have been the overall impacts of the DoD T2 system on the nation's defense mission? The answers to these questions are largely unknown, although TechLink's economic impact studies provide periodic high-level insights.

Figure 20 shows that the metrics used to evaluate the effectiveness of the DoD T2 system are essentially limited to measuring activities and outputs. These metrics consist primarily of tallies of the numbers of invention disclosures, patent applications, issued patents, license agreements, and CRADAs. (Licensing income is also a metric, but the relatively small amounts received compared to the size of the DoD budget make this income seem almost insignificant.)

What is DoD's T2 strategy? As this figure indicates, there is a gap between technology transfer and transition. The strategic vision of T2 basically stops at the DoD laboratory gates. Having an impact on the defense mission is a distant aspirational goal, as is indicated by the one-way T2 strategy arrow pointing toward this mission. However, no significant resources or activities are devoted to achieving this goal. There is virtually no explicit strategy to link the agency's T2 operations to the desired impacts on the defense mission. Finally, as this logic model shows, there is no feedback mechanism connecting the defense mission to DoD's T2 operations.

Detailed Shortcomings of the DoD T2 System

While Figure 20 depicts the major shortcomings on the current DoD T2 system, it does not provide the finer-grained details necessary to fully understand the deficiencies in each of the major elements of this system. These details are provided in Figure 21, which focuses on each of the major elements—the inputs, activities, outputs, intermediate outcomes, end outcomes, and impacts—and summarizes the deficiencies in each of these elements.

The **Inputs** element in Figure 21 shows that many DoD labs lack established and fully documented T2 policies and procedures. In fact, only 41% of the DoD T2 managers reported that their labs had such policies and procedures.

Many other essential Inputs for a successful T2 system are also lacking, including sufficient staffing and funding for the T2 function. The budget provided by DoD for its T2 function is grossly inadequate, and many of the shortcomings in the DoD T2 system reflect this funding shortfall.

See Figure 21 on the next page

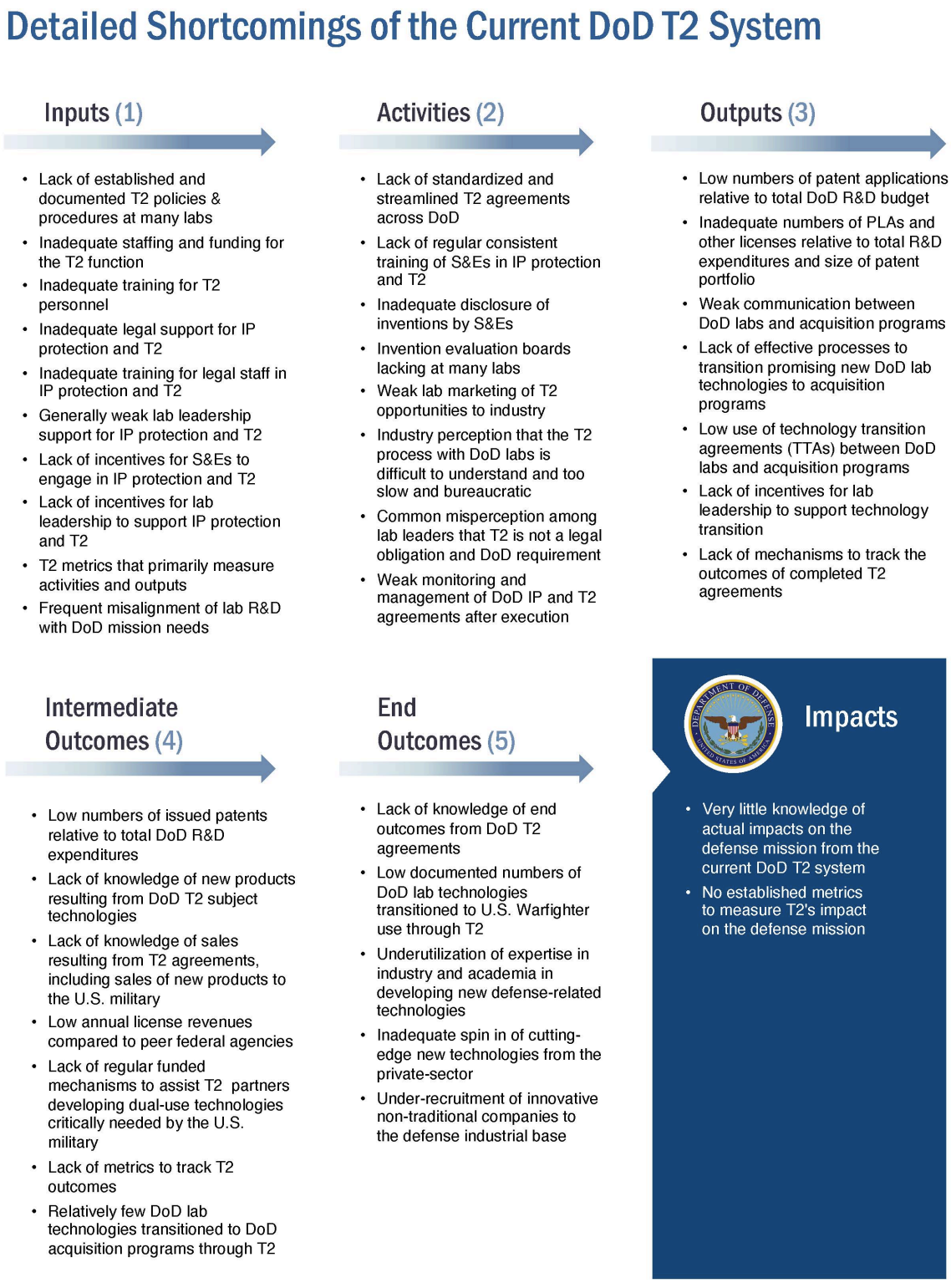


Figure 21. Detailed Shortcomings of the Current DoD T2 System

PL 96-480 enacting the Stevenson-Wydler Act originally required each federal agency with at least one laboratory to make available "not less than 0.5 percent of the agency's research and development budget" to support its T2 function. Not specified was *which* R&D budget should be used for this calculation—for example, DoD's total R&D budget, which is currently around $70 billion a year, or the much smaller intramural R&D budget expended in DoD's own laboratory system.

DoD's total intramural R&D budget is now approximately $24 billion per year. Consequently, 0.5% of that amount would be $120 million. Per the original intent of the Stevenson-Wydler Act, DoD now should be spending *at least* $120 million annually on T2. However, the 0.5 percent stipulation was replaced in 1989 with "sufficient funding." Federal agency T2 has been poorly funded ever since.

DoD currently is spending only around $58 million a year on T2. This is *less than half of* the amount intended by Congress when it passed the Stevenson-Wydler Act.

Per a recent survey by OSD, approximately 240 DoD personnel are currently involved in T2 (including ORTAs and lawyers supporting T2). Assuming a generous, fully burdened rate of $200,000 per year per individual, DoD's annual personnel budget for T2 would be $48 million. To this should be added the annual budget for TechLink, DoD's national T2 partnership intermediary. TechLink's average core budget for FYs 2020-2022 was $3.1 million per year. DoD also expends approximately $4.5 million per year for patenting costs, including filing fees, maintenance fees, and miscellaneous expenses.[2] Finally, an estimated $2.4 million per year is spent for miscellaneous T2-related activities, such as travel. Together, these expenditures total $58 million—far less than the amount necessary for DoD's legally mandated T2 function.

Most DoD T2 managers (87%) stated that they lacked the resources and support that they needed to be successful, including the necessary personnel, funding, training, legal support, lab leadership support, cooperation from S&Es, and other essentials. These deficiencies were substantiated by the responses from other DoD groups. For example, a large majority of the legal community (83%) stated that they lacked the resources and support they needed to adequately protect DoD inventions and other intellectual property, including the training necessary to be successful at these activities.

In the current DoD T2 system, there is generally weak lab leadership support for IP protection and T2. Fully a third of the S&Es interviewed reported that their branch or division chiefs didn't think these activities were important. In fact, one S&E claimed that their branch manager actively discouraged them from disclosing inventions or participating in T2, referring to these activities as "a waste of time."

In the majority of DoD labs, S&Es are not provided any significant incentive to engage in IP protection and T2, such as by being evaluated in annual performance reviews on their participation in these activities. Compounding this problem, 44% of the S&Es interviewed stated that they did not have enough time in their daily jobs to write invention disclosures or to interact with industry; 39% reported that they didn't have a budget to charge time to for these activities; 39% claimed that the legal office didn't provide the necessary support; 28% believed these activities were not important for career advancement; and 22% stated that they didn't understand the process.

[2] This figure was calculated using the average figure of 601 patents/year during the FY 2017-2021 period at $7,500 per patent. The $7,500 figure includes the average DoD cost per patent for the Army, Navy, and Air Force of $6,770 for standard patenting expenses, taking into account all documented DoD patent filing and maintenance fees since 2003, plus an estimated $730 per patent for extra costs that are incurred during prosecution for items such as time extensions, petitions, and appeals.

In the current DoD T2 system, DoD lab leaders lack incentives to support IP protection and T2. In addition, the metrics used to evaluate the effectiveness of T2 primarily measure activities and outputs rather than inputs, outcomes, and impacts. Three-fourths (76%) of the DoD T2 managers stated that they thought DoD's T2 metrics could be improved and 67% of the lab lawyers interviewed said the same.

Finally, many interviewees noted that DoD lab R&D is often not well-aligned with DoD mission needs, which directly affects the outcomes and impacts of the DoD T2 system. In fact, 88% of the lab leaders interviewed believed that their lab's R&D goals and metrics could be improved to better support the defense mission. And 83% of the S&Es interviewed shared that opinion.

In the **Activities** element, a notable shortcoming is the lack of standardized and streamlined T2 agreements within the DoD lab system. DoD and private-sector interviewees alike cited this as a problem. Diverse DoD personnel also noted the lack of regular consistent training of S&Es in IP protection and T2. In fact, 55% of the T2 managers interviewed said they did not consistently provide training to S&Es in IP protection and T2, primarily because of a lack of "bandwidth," and 33% of the lawyers supporting T2 said the same.

Another widespread problem is inadequate disclosure of inventions at the labs, as noted by 44% percent of the lab leaders interviewed and 61% of the IP attorneys. Substantiating this point, in FY 2017 (the last year for which T2-related information was publicly available for all federal agencies when this report was being drafted), DoD disclosed only 978 inventions, which was one invention for every $17.4 million expended in DoD lab intramural R&D funding (NIST 2021). By comparison, the Department of Energy (DOE) disclosed 1,794 inventions, one per every $4.6 million in intramural R&D funding, and NASA disclosed 1,690 inventions, one per every $2.1 million in intramural R&D (NIST 2021).[3]

The majority of DoD labs also lack an Invention Evaluation Board (IEB) or Invention Evaluation Committee (IEC) to evaluate inventions disclosed by S&Es prior to seeking patent protection. In fact, according to the IP lawyers interviewed, only 44% of the DoD labs have IEBs or IECs.

Weak or virtually non-existent lab marketing to industry of DoD T2 opportunities, especially of CRADAs, is an additional shortcoming in the Activities element. Further, two-thirds of DoD's private-sector T2 partners said that establishing a T2 agreement with DoD was not a smooth and timely process. Among this group, 74% said it was difficult to figure out the process; 50% said it took too long to establish the agreement; 47% said the process seemed too bureaucratic; 38% said the terms were not favorable to the company; 24% said the DoD T2 personnel were not very helpful; and 21% said the lab's lawyers were difficult to work with.

A further structural weakness is the common misperception among lab leaders that T2 is neither a legal obligation nor a DoD requirement. Only 44% of the lab leaders interviewed understood that T2 is *both* a legal obligation (15 USC §3710 and 10 USC §2514) and a DoD requirement (DoD Instruction 5535.08). This lack of understanding leads to weak support for IP protection and T2 among lab leaders and contributes significantly to shortcomings in all elements of the DoD T2 system. Finally, many interviewees noted the weak monitoring and management of DoD IP and T2 agreements following their execution.

Deficiencies in the **Outputs** element stem from the shortcomings in the Inputs and Activities elements. Interviewees (as well as the reviewed government reports on DoD T2) noted the relatively low numbers of patent applications in relationship to the DoD laboratory system's very large total R&D expenditures—$17 billion in FY 2017, which was approximately 40% of the entire U.S. federal government's intramural R&D

[3] In FY 2017, DoD's total intramural R&D budget (including FFRDCs) was $17,007 million, versus $8,167 million for DOE and $3,574 million for NASA (NIST 2021).

budget (NIST 2021). In addition, there are relatively low numbers of license agreements, given the size of these expenditures and even the size of DoD's patent portfolio.

Many interviewees noted the weak or virtually non-existent lines of communication between DoD's labs and its acquisition programs. In fact, 38% of the DoD lab leaders stated that they never interacted with acquisition programs to brief them on new technologies that their lab had developed. Strong lines of communication are essential to make the acquisition community aware of new lab technologies that are promising candidates for acquisition. These lines of communication also are crucial to enable DoD lab leaders to understand the critical technology needs of DoD's acquisition programs and how their labs can meet those needs.

Many interviewees also noted that DoD lacked clearly established, adequately funded processes to transition promising new DoD technologies to acquisition programs. In fact, 69% of the acquisition program interviewees cited this as a problem, as did 56% of the lab leaders. An aspect of this problem is the relatively low use of TTAs between DoD labs and acquisition programs. TTAs are designed to facilitate the transition of DoD lab technologies to acquisition programs. Consequently, their low level of use is an impediment to transition.

Another problem in the DoD T2 system is the lack of incentives for DoD lab leaders to try to transition their lab's new technologies to acquisition programs in order to benefit the U.S. Warfighter. The majority of the interviewed DoD lab leaders reported that they were not incentivized in their performance reviews to try to transition their lab's technologies. Only 44% said they were incentivized in some way, but most of those respondents said that transitioning lab technology was not given any priority. In fact, only 7% of the interviewed DoD lab leaders said transitioning lab technology was explicitly part of their performance evaluations.

Finally, interviewees and reports on DoD T2 frequently cited the lack of mechanisms to track the outcomes of licenses and CRADAs. Such mechanisms are essential to enable DoD to learn of important outcomes, such as the development of dual-use (commercial as well as military) products by DoD's T2 partners that could help meet critical DoD technology needs.

Shortcomings in the **Intermediate Outcomes** element include the low numbers of issued patents relative to the size of the DoD lab R&D expenditures. For example, DoD generated one issued patent for every $27 million in intramural R&D funding in FY 2017, compared to a patent obtained by Health and Human Services (HHS) for every $14 million of R&D and one by DOE for every $10 million in R&D (NIST 2021).[4]

Another major failing is a lack of knowledge of the outcomes themselves, such as development of new dual-use or military products. Knowledge of the Intermediate Outcomes of most DoD CRADAs has historically been essentially non-existent.[5] For license agreements, the situation is only slightly better. The annual royalty reports that licensees submit with their royalty checks cite the commercial sales of the license technology on which royalties are assessed. However, these reports typically provide little additional information. They generally do not include sales to DoD or other U.S. government entities, which are almost always non-royalty bearing and not required to be reported. Lack of reporting of sales to the U.S. military keeps DoD leaders from understanding the effectiveness of DoD's T2 system and, more generally, the impact of DoD's laboratory enterprise on the defense mission.

4 In FY 2017, DoD was issued 630 patents compared to HHS's 554 patents and DOE's 817 patents. That year, DoD's total intramural R&D budget (including FFRDCs) was $17,007 million, versus $7,799 million for HHS and $8,167 million for DOE (NIST 2021).
5 TechLink's economic impact studies are beginning to provide high-level insights into DoD's CRADAs, as explained in the literature review in this report (Appendix 3).

DoD's annual license revenues are also relatively low compared to those received by other federal agencies. In FY 2017, for example, DoD received total income from its licenses of around $7.4 million (NIST 2021). By contrast, that same year, HHS received $135 million in total licensing income, DOE received $37 million, and the USDA received $6 million (NIST 2021).

Another shortcoming cited by a significant number of interviewees is the lack of established, funded mechanisms to assist DoD's T2 partners that are developing dual-use technologies critically needed by the U.S. military. Related to this is the lack of incentives for major defense contractors to subcontract with DoD lab licensees or CRADA partners when those T2 partners could produce the needed technology at a significantly lower cost than the contractors themselves. This differs from the situation with DoD's Small Business Innovation Research (SBIR) awardees, in which prime contractors are incentivized or strongly encouraged to subcontract with SBIR companies when it benefits DoD. Similarly, DoD licensees or CRADA partners who have developed critically needed military products based on their T2 agreements are not given any preference in selling those products to DoD—for example, by being allowed to receive sole source contracts. Again, this is very different from the DoD SBIR program in which DoD SBIR Phase II-funded companies are provided the right to receive non-competed contracts from DoD or any other U.S. federal agency. Significant percentages of DoD's T2 partners, including 29% of licensees and 20% of CRADA partners, reported having difficulty selling their T2-related products to DoD, even though they believed that DoD had a critical need for those products.

As a result of the above shortcomings, relatively few DoD lab technologies have transitioned to DoD acquisition programs through the T2 mechanism. A final problem in the Intermediate Outcomes element is the lack of metrics to measure these outcomes.

Weaknesses in the **End Outcomes** element of the DoD T2 system stem directly from deficiencies in the previous elements. In fact, there is relatively little knowledge of the end outcomes from most DoD CRADAs and license agreements, particularly of the defense-related outcomes. The number of DoD lab technologies transitioning to DoD programs of record through the T2 mechanism is largely undocumented and is believed to be relatively low. Because of the previously mentioned shortcomings in its T2 system, DoD suffers from an underutilization of the expertise and resources in industry and academia in developing new defense-related technologies. It also fails to benefit from many cutting-edge new technologies in virtually all technology fields being developed by the private sector (particularly by small, innovative companies), which could be spun in through the T2 mechanism. As a result, the defense industrial base is neither as innovative, agile, diversified, or robust as it potentially could be.

Having a substantial impact on the defense mission should be a major goal of the DoD T2 system. However, as the **Impacts** element in Figure 21 indicates, very little is known about DoD T2's actual impacts on the defense mission. As more fully discussed in the T2 literature review (Appendix 3), TechLink's periodic economic impact studies estimate the total impact of DoD T2 on the U.S. economy using direct surveys of DoD's private-sector T2 partners and IMPLAN modeling (TechLink 2013, 2016, 2019a, 2019b, 2021, 2022). In addition, these studies capture sales to the U.S. military of which interviewed companies are aware. TechLink supplements these EIS with notable T2 success stories discovered in its company interviews. However, these success stories reveal only a tiny slice of DoD T2's impacts. The total impacts remain largely unknown. There are currently no established metrics used to measure and evaluate the DoD T2 system's impacts on the defense mission.

Task 4: Develop New DoD T2 Impact Model

Develop a DoD T2 Impact Model, representing an improved DoD T2 system, using information and insights from detailed interviews, relevant studies and reports, and analysis of the current DoD T2 system.

Methodology

Constructing the logic model of the current DoD T2 system, including analyzing the shortcomings of each of its major elements, enabled the TechLink team to envision the changes necessary to improve this system. This allowed the team to develop the proposed new "DoD T2 Impact Model" and formulate a suite of recommendations and proposed new metrics for potential use by DoD policymakers.

"Constructing the logic model of the current DoD T2 system, including analyzing the shortcomings of each of its major elements, enabled the TechLink team to envision the changes necessary to improve this system."

The TechLink team was guided by the previously mentioned RAND Corporation study of how logic models can be used to evaluate DoD laboratory T2 (Landree and Silberglitt 2018). In that study, the authors demonstrated how logic models can help program managers understand the interrelationships between the basic elements of their program—the inputs, activities, outputs, outcomes, and impacts—and align those elements with the program's mission and goals (Landree and Silberglitt 2018).

To develop the DoD T2 Impact Model, the TechLink team first carefully considered the results of the previous project tasks: the literature review, in-depth interviews, and construction of the logic model of the current DoD T2 system. Then it initiated development of the T2 Impact Model with several important design goals in mind.

One major goal was to enable DoD policymakers at both the Pentagon and lab levels to track DoD lab inventions and T2 agreements to their ultimate outcomes. This would allow these DoD leaders to evaluate the impact of their T2 operations on the defense mission. More broadly, it would help them to assess the mission-related impacts of DoD lab R&D.

A second goal was to help DoD policymakers develop a comprehensive DoD T2 strategy. That is, starting with the desired impacts on the defense mission, they could reverse-engineer the necessary strategic goals, intermediate goals, annual goals, and initial management goals to devise an effective T2 strategy.

A third goal was to help DoD policymakers and T2 program managers identify the essential ingredients for each major element in the T2 system—the inputs, activities, outputs, intermediate outcomes, and end outcomes. This would enable them to optimize each of these elements to create a more effective and productive T2 system that would have a greater impact on the defense mission and national economy.

A fourth goal was to help DoD leaders ensure that DoD's T2 operations are completely aligned with its T2 strategy. For example, the T2 inputs should be aligned with the T2 management goals. The T2 activities and outputs (such as the submitted patent applications and signed license agreements and CRADAs) should line up with the annual T2 goals. The intermediate outcomes (such as the issued patents and new products resulting from T2 agreements) should correspond to the intermediate goals. Finally, the desired end outcomes should be aligned with the T2 strategic goals.

A fifth goal, closely related to the fourth goal, was to integrate effective T2 metrics into the T2 Impact Model to help achieve successful outcomes and impacts. DoD policymakers and T2 program managers need to be able to measure progress at all stages of their T2 operations, to ensure these operations are meeting the established goals. Quantitative metrics can be used to assess inputs, activities, and outputs. However, they need to be augmented with qualitative metrics to assess T2 outcomes and impacts.

A final goal was to connect DoD's T2 operations firmly and seamlessly to its technology transition activities. This represents a major paradigm shift in how T2 is viewed within DoD's overall effort to deliver new technologies to the U.S. Warfighter.

DoD T2 and Technology Transition

"Technology transition" is generally understood to mean insertion of a technology into a DoD acquisition program, leading to operational use of this technology by the U.S. military. However, the term is inconsistently used within DoD, leading to confusion. In a memo dated June 13, 2022, Ms. Heidi Shyu, the Under Secretary of Defense for Research and Engineering and DoD's Chief Technology Officer, listed six different pathways by which technology can "transition" in an effort to help standardize the DoD definition. These include:

1) Insertion of the technology into a DoD program
2) Software implemented on existing system
3) Follow-on technology maturation program
4) Transitioned to industry (defense or commercial)
5) Transitioned to other Government Agency
6) Fielding a new capability

As used in this report, *transition* primarily refers to "insertion of the technology into a DoD program" and "fielding a new capability." It could also include "software implemented on existing system" if the software in question was a private-sector product acquired by DoD, rather than a software program developed and implemented internally within DoD, without industry involvement. The other three pathways are not included in this report's definition of transition. Two of these pathways, "transitioned to industry" and "transitioned to other Government Agency," actually refer to technology *transfer* rather than transition. Finally, "follow-on technology maturation program" represents a different concept of transition in which the goal is to advance a technology's "technology readiness level" or manufacturability, often to prepare it for DoD acquisition.

Currently, there is a major disconnect between DoD T2 and technology transition. T2 operations are considered essentially complete when a license agreement is executed or a CRADA project ends. There is typically no follow-up to determine what happened after the T2-subject technology left the DoD facility. While license agreements and CRADAs have reporting requirements, those requirements generally ignore outcomes related to the defense mission.

There is also little effort to assist T2 partners that are developing dual-use T2-related products with significant potential to meet critical U.S. military technology needs. In fact, the DoD acquisition community

is often unaware of important emerging DoD lab technologies that could meet DoD mission needs through a coordinated T2 and technology transition process.

T2 is perceived by many in DoD lab leadership and the acquisition community as neither a legal obligation nor a DoD requirement. Consequently, even if they publicly support T2, they largely ignore it when considering technology transition. Transition is generally viewed as an activity involving DoD acquisition programs and defense contractors, often without any DoD lab participation. To the degree that it involves DoD labs, it usually consists of acquisition programs funding lab S&Es for technology development to meet DoD requirements, after which the technology is turned over to defense contractors for final product development and manufacture.

Technology transition in the current DoD system rarely involves T2 mechanisms. In fact, it is poorly understood that T2 is an important but greatly underutilized pathway to accomplish technology transition. Figure 22 presents a holistic overview of the DoD technology transfer and transition system and shows the two major pathways through which new technology reaches the U.S. Warfighter (explained below).

As Figure 22 shows, starting with the upper-right Technology Requests arrow, technology needs are communicated by DoD Warfighters and others to the Pentagon, primarily to the offices of the Under Secretary of Acquisition and Sustainment and the Under Secretary of Research and Engineering. These needs are then communicated to the acquisition programs and labs in the Army, Navy, Air Force, and independent DoD agencies. Both Pentagon offices and their subordinate acquisition programs provide funding for DoD labs to develop new technology, as shown by the upper-left green Funding arrow. In general, the Research and Engineering Office provides general funding for basic research, and the Acquisition and Sustainment Office provides funding for specific lab R&D projects to meet specified technology needs.

New technologies flow from DoD labs back to DoD acquisition programs, as indicated by the upper-left blue New Technologies arrow. Most of the time, these new technologies were developed under funding for specific research projects. However, if acquisition programs become aware of important new lab technologies, they can establish TTAs with the DoD labs to intake these technologies into their programs.

See Figure 22 on the next page

Figure 22. DoD Technology Transfer and Transition

The lower-left green two-way Funding arrow indicates that U.S. industry can provide funding to DoD labs under CRADAs for joint R&D projects to develop new dual-use technologies. DoD labs can also provide funding to companies for new technology development through SBIR and many other programs (SBIR is commonly considered in DoD to be a form of "spin-in" T2). The lower-left blue two-way arrow shows that, under T2 agreements, new technologies and knowledge can flow in either direction between DoD labs and U.S. industry. This two-way arrow depicts the Technology Transfer process.

The lower-right New Military and Dual-use Products arrow represents *Technology Transition*. Technology transition occurs through two major pathways. *Pathway 1* consists of DoD acquisition contracts with defense contractors, who either develop a desired new technology after a successful bid or develop a technology through their own independent R&D programs and subsequently sell it to DoD acquisition programs. This is shown by the middle green Funding arrow and the middle blue two-way New Technologies arrows connecting DoD acquisition programs with U.S. industry.

Pathway 2 consists of acquisition contracts with companies that generally are not traditional defense contractors but that have developed dual-use and military products through T2 agreements with DoD labs. This pathway involves direct interactions between DoD labs and U.S. industry (the lower-left, middle, and lower-right arrows). It previously was fully illustrated in the "DoD T2 – Technology Transition Pathway" graphic (Figure 1).

For technology transition to occur through Pathway 2—the T2 pathway—DoD acquisition programs need to establish contracts with DoD license, CRADA, or SBIR partners who have developed important new technologies or products through their T2 or SBIR agreements. This requires the companies to make DoD acquisition programs aware of and interested in their offerings. This is usually a heavy burden, because most DoD licensees and SBIR companies and many CRADA partners are not traditional defense contractors and do not understand how to sell to DoD. Also, there are relatively few programs to help them. As a result, Pathway 1 is the primary way that new military and dual-use products are transitioned to the U.S. Warfighter. However, Pathway 2 is an important alternative route that is frequently ignored and greatly underutilized by DoD.

The DoD T2 Impact Model is intended to substantially increase the importance of the T2 pathway to achieve transition. As previously mentioned, this will involve a paradigm shift in how T2 is viewed. DoD T2 needs to become recognized as one of DoD's most important and cost-effective transition programs—the primary conduit of new technologies developed or co-developed in DoD's own vast laboratory system.

Summary of Results

The DoD T2 Impact Model is depicted in Figure 23. As the top arrow shows, in the proposed new T2 system, *T2 operations* are considered to extend all the way from Pentagon policymakers on the left to the desired "Impacts on the Defense Mission" on the right. In addition, T2 operations are deemed to encompass not only the inputs, activities, and outputs but also the outcomes and impacts. This represents the previously mentioned major paradigm shift in how DoD T2 is viewed.

See Figure 23 on the next page

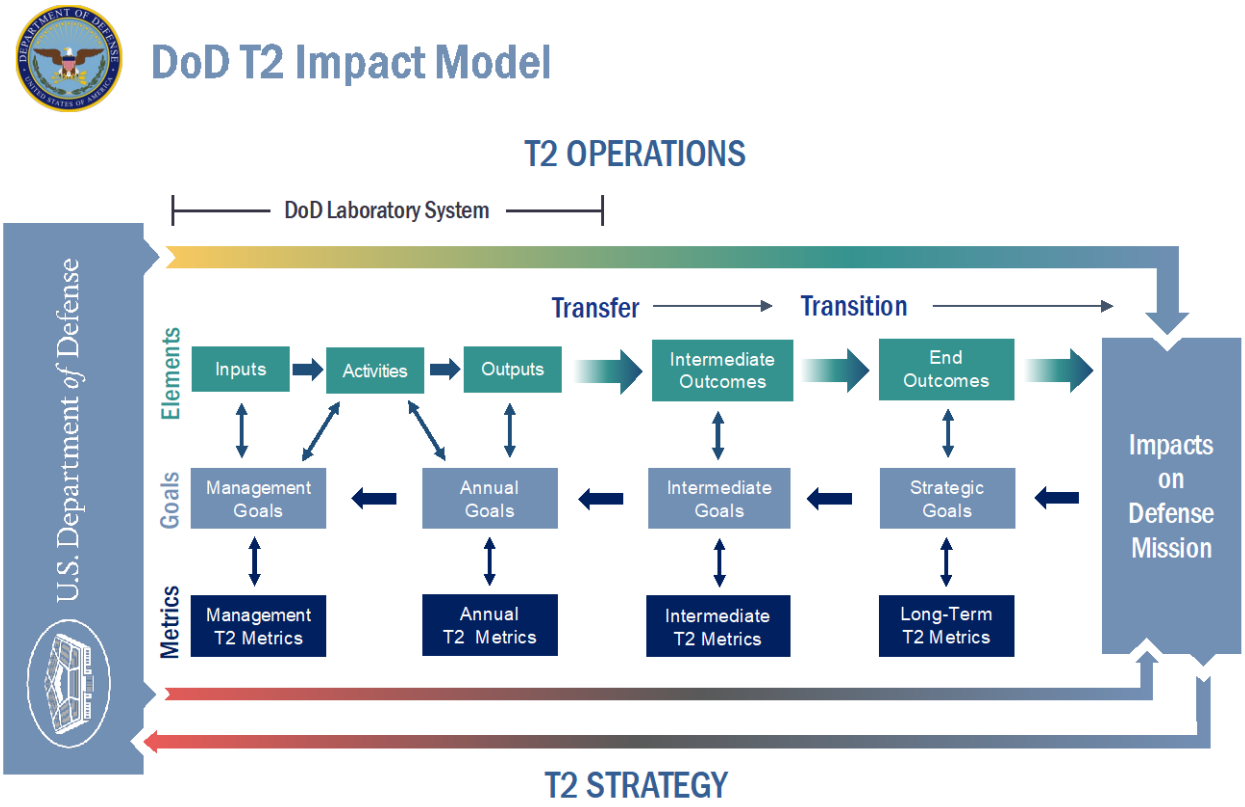


Figure 23. DoD T2 Impact Model

Unlike the current T2 system's "out-the-door" *modus operandi*, in which the T2 operation is essentially considered to end when a license agreement is executed or CRADA project is completed, the new paradigm portrayed in Figure 23 requires follow-on tracking of the T2-subject technology *after* it leaves the lab, to learn of its subsequent fate. This change is essential to enable DoD policymakers to evaluate the effectiveness of DoD's T2 operations and to understand their contribution to the defense mission. It also is crucial to enable DoD policymakers to evaluate the impacts of the DoD laboratory enterprise on the defense mission.

In the DoD T2 Impact Model, DoD's *T2 strategy* is viewed as extending all the way from the Pentagon to the defense mission—in parallel with DoD's T2 operations. There also is a feedback loop. This is shown by the reverse T2 strategy arrow connecting the defense mission to the Pentagon. It is additionally indicated by the right-to-left arrows in the middle of the diagram pertaining to goals. In fact, the DoD T2 Impact Model is designed to help DoD policymakers develop a comprehensive DoD T2 strategy. Starting with the desired defense-mission impacts in mind, they can reverse-engineer the strategic goals, intermediate goals, annual goals, and initial management goals necessary to devise an effective and successful T2 strategy.

The DoD T2 Impact Model is designed to help DoD policymakers and T2 managers identify the essential ingredients for each major element in the T2 system—the inputs, activities, outputs, intermediate outcomes, and end outcomes. Through optimizing each of these elements, these leaders can create a more effective T2 system that will have a greater impact on the defense mission and national economy.

The DoD T2 Impact Model also is designed to ensure that DoD's *T2 operations* are completely aligned with its *T2 strategy*. Starting from the left, the T2 program Inputs and Activities are aligned with the T2 Management Goals. This is indicated by the vertical and diagonal arrows. The T2 Activities and Outputs line up with the Annual Goals.

The Intermediate Outcomes are aligned with the Intermediate Goals. Finally, the desired T2 End Outcomes are aligned with the T2 Strategic Goals.

The T2 Impact Model additionally enables DoD policymakers and T2 managers to establish appropriate metrics for each phase of the T2 operations, so they can monitor these operations to ensure they are achieving their goals. The *Management T2 Metrics* enable evaluation of the Management Goals and T2 Inputs and Activities. The *Annual T2 Metrics* allow DoD to determine whether the T2 Activities and Outputs of individual DoD labs or the entire Defense laboratory enterprise are meeting their established Annual Goals. The *Intermediate T2 Metrics* enable assessment of whether the T2 Intermediate Outcomes are meeting the established Intermediate Goals. Finally, the *Long-Term T2 Metrics* can be used to measure whether the End Outcomes are meeting the overall Strategic Goals.

Finally, the DoD T2 Impact Model solidly and seamlessly connects T2 to technology transition. It is designed to eliminate the current gaps between these two essential activities in delivering innovative technology developed or co-developed by DoD's lab system to the U.S. Warfighter.

Features of the Improved DoD T2 System

Figure 23 highlights the principal features of the improved DoD T2 system being proposed. However, it does not provide the details necessary to overcome the deficiencies in each of the major elements of the current DoD T2 system—the inputs, activities, outputs, intermediate outcomes, end outcomes, and impacts. Figure 24 summarizes these details.

The **Inputs** element in Figure 24 shows that the essential starting point for the improved DoD T2 system is a strong DoD T2 strategy focused on impacts on the defense mission. A second, closely related feature is established and fully documented T2 policies and procedures at all labs. As previously mentioned, only 41% of the DoD T2 managers reported that their labs currently had such policies and procedures.

Adequate staffing, funding, and training for DoD's T2 function are also essential. Most of the DoD T2 managers interviewed (87%) stated that they lacked the resources and support they needed to be successful. These deficiencies were substantiated by the responses from other DoD groups, particularly the legal community. To ensure adequate staffing and funding, the improved T2 system needs top-level DoD support. Further, it is essential that lab leadership understands that T2 is not only a legal obligation but an explicit DoD requirement for all DoD labs. S&Es also need to be incentivized to fully participate in IP protection and T2 (ideally through their annual performance reviews).

To ensure these key inputs are provided and sustained, the improved DoD T2 system needs strong incentives for lab leaders to support IP protection and T2. The necessary incentives would likely include designating effectiveness in IP protection and T2 as rated elements in the annual performance reviews of DoD lab leaders. This improved system also requires established metrics that measure inputs, outcomes, and impacts—not just activities and outputs.

Finally, as many Task 2 interviewees noted, DoD lab R&D is often not well-aligned with DoD mission needs. This directly affects the mission-related outcomes and impacts of the DoD T2 system. To improve this system, an essential starting input is strong alignment between DoD technology needs and the R&D being conducted in DoD's laboratory system.

See Figure 24 on the next page

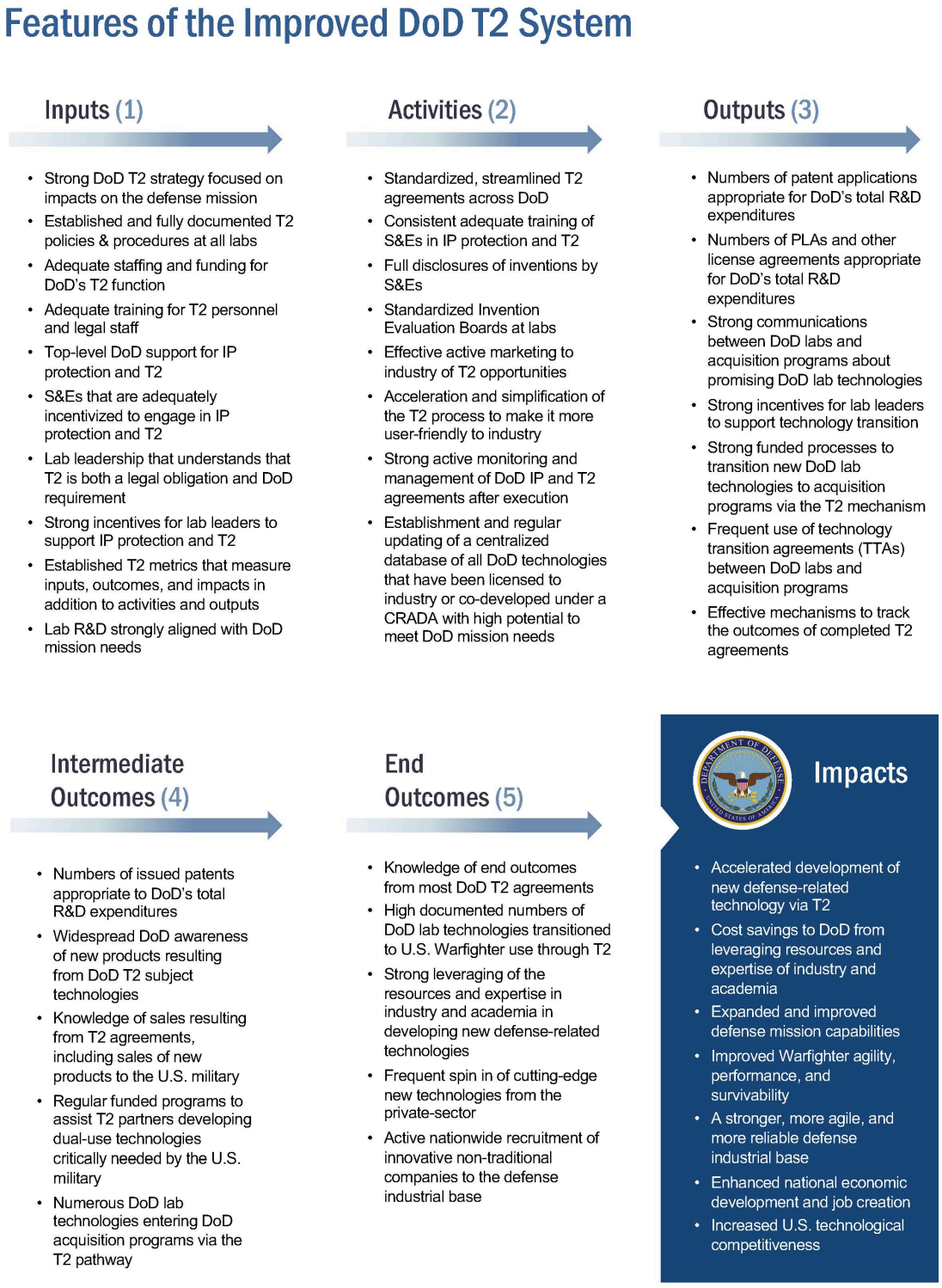


Figure 24. Features of the Improved DoD T2 System

As Figure 24 shows, the **Activities** element in the improved DoD T2 system is characterized by standardized and streamlined T2 agreements across the DoD laboratory enterprise. Approximately a third of the interviewed company executives complained about DoD's lack of standardized and streamlined T2 agreements, which required them to engage lawyers to review the agreement terms whenever they interacted with a new DoD lab or even entered into subsequent agreements with the same lab. Having standardized and streamlined T2 agreements would also free up substantial time for DoD's T2 and legal staff.

Other essential features of the improved DoD T2 system include consistent adequate training of S&Es in IP protection and T2; S&Es fully disclosing their inventions; and establishment of IEBs at all relevant labs to evaluate inventions disclosed by S&Es prior to seeking patent protection.

The improved T2 system additionally requires effective, active marketing of CRADA and other T2 opportunities. It also is characterized by a clearly understandable, expeditious T2 agreement process, to overcome the complaint by company executives interviewed that the T2 process with DoD is difficult to understand and overly bureaucratic and time consuming.

An additional feature is a robust system for monitoring and managing DoD's inventions and T2 agreements after they are executed. Finally, the improved DoD T2 system has a centralized database of all dual-use DoD technologies that have been licensed to industry or co-developed under CRADAs that are believed to have good potential to meet DoD mission needs.

These improvements in the Inputs and Activities elements will address some of the current deficiencies in the Outputs element. The **Outputs** element in the improved DoD T2 system is characterized by numbers of patent applications and license agreements that roughly correspond to the size of DoD's R&D expenditures.

Other essential features of the Outputs element include strong lines of communications between DoD's labs and acquisition programs about promising lab technologies; strong incentives for lab leaders to support technology transition, such as by making effectiveness in transitioning lab technologies to acquisition programs a rated element in annual performance reviews; strong, funded mechanisms to transition critically needed DoD lab technologies to acquisition programs via the T2 mechanism; and regular, frequent use of TTAs between DoD labs and acquisition programs. Finally, there are effective mechanisms and metrics to track the outcomes of DoD licenses and CRADAs.

Most of the current shortcomings in the **Intermediate Outcomes** element would be addressed by the previously mentioned improvements. Features of this element now include an increased number of issued patents to match the size of DoD's R&D expenditures; widespread DoD awareness of the new products that have resulted from its T2 agreements and the sales of these products to the U.S. military; established funded programs to assist DoD T2 partners (both licensees and CRADA partners) that are developing dual-use technologies critically needed by the U.S. military; and a greatly increased number of DoD lab technologies entering DoD acquisition programs via the T2 pathway.

The **End Outcomes** element of the improved DoD T2 system features knowledge of the end results from most DoD CRADAs and license agreements; high documented numbers of DoD lab technologies being transitioned to DoD operational use through the T2 pathway; strong leveraging of the resources and expertise of industry and universities in developing new defense-related technologies; and a regular infusion into DoD, through T2 mechanisms, of cutting-edge new technologies from the private sector, particularly from small, innovative companies. A final feature is active nationwide recruitment into the defense industrial base of innovative non-traditional defense contractors—both small technology firms and major corporations.

Finally, in the improved DoD T2 system, the **Impacts** element includes accelerated development of new defense-related technology via the T2 pathway; cost-savings to DoD from leveraging the resources and expertise of industry and universities; expanded and improved defense mission capabilities benefiting from advances in virtually all technology fields; continuous improvements in U.S. Warfighter agility, performance, and survivability; a stronger, more diversified, and reliable defense industrial base; enhanced national economic development and job creation; and increased U.S. technological competitiveness.

In short, by implementing the DoD T2 Impact Model, the Department of Defense will enable the DoD laboratory system to have a much greater impact on the defense mission. In addition, this system will achieve a substantially greater impact on the U.S. economy and American public.

Task 5: Recommendations to Implement the DoD T2 Impact Model

Formulate a detailed, prioritized set of recommendations to help DoD policymakers implement this new model.

Methodology

The previous task focused on what needs to be done to improve the DoD T2 system. However, it didn't specifically indicate *how* DoD should effect these changes. This task addresses the "how" question and provides a comprehensive set of recommendations and metrics to help DoD policymakers successfully implement the DoD T2 Impact Model.

This task generated a comprehensive set of recommendations and metrics to help DoD policymakers implement the DoD T2 Impact Model.

Most of these recommendations and proposed metrics emerged from the Task 2 interviews. A few were drawn from the Task 1 literature review or collective hands-on experience of the TechLink research team. As previously discussed, all interviewees were asked for recommendations to address the shortcomings that they noted. In addition, in response to the open-ended questions, they frequently offered suggestions on how DoD should improve its T2 system. Many of their recommendations were similar or virtually identical, revealing widely shared views.

The project generated 232 specific recommendations for consideration by DoD, including 44 proposed new metrics. Each of these is a unique recommendation. For example, if 40 interviewees offered essentially the same suggestion, it is presented as only one of the 232 total recommendations.

One of the project's most difficult challenges was determining how to organize this large number of recommendations in a meaningful and actionable way. The research team first organized these recommendations according to the element of the DoD T2 system into which they best fit—inputs, activities, outputs, intermediate outcomes, end outcomes, or impacts. This approach was intended to help DoD policymakers focus on improving each of the major elements of the DoD T2 system.

To further assist policymakers, the research team sorted the recommendations into three different tiers, each tier representing a different level of difficulty in implementation. *Tier I recommendations* are the "low-hanging fruit"—the proposed low-to-no-cost solutions that DoD can most readily and rapidly implement without needing additional funding or policy changes. *Tier II recommendations* are solutions that need some additional funding and/or policy changes, taking longer and requiring more effort to implement. *Tier III recommendations* are solutions that require substantial additional funding and policy changes. To a significant extent, there is an inverse relationship between the tier level and the expected impact. Although Tier III solutions would take the greatest effort to implement, they would likely have the greatest impact.

Next, to help policymakers prioritize potential actions to improve the DoD T2 system, the research team ranked the recommendations by their anticipated beneficial impact. Each member of the five-member research team plus TechLink's Executive Director ranked each recommendation using a 1 to 5 scoring system, with 1 representing the highest score and greatest expected impact, and 5 representing the lowest expected impact. The total points assigned to each recommendation were subsequently averaged and rounded off to the nearest whole number, to represent the collective judgment of the research team.

The recommendations then were labeled to indicate which of the six functional categories they addressed: strategy and policies; resources; education and training; processes and procedures; acquisition; and metrics. Many recommendations span multiple categories. This functional categorization will help policymakers search the recommendations for potential actions—for example, should they decide to focus on improving T2 education and training.

Finally, all recommendations were distilled into their common denominators. This was accomplished using the previously described open coding process. All 232 recommendations were analyzed, categorized, and then combined based on their common themes. This yielded a final set of ten major recommendations.

Summary of Results

Table 3 shows the total number of recommendations (including metrics) for each element, tier, and rank score. Enumerated by **element**, 83 of the total 232 recommendations pertained to Inputs, 68 to Activities, 49 to Outputs, 20 to Intermediate Outcomes, 5 to End Outcomes, and 7 to Impacts. Sorted by **tier**, 128 recommendations were assigned to Tier I, 74 to Tier II, and 30 to Tier III. Sorted by **rank score**, 64 recommendations were assigned a top score of 1, 83 recommendations a score of 2, 72 a score of 3, and 13 a score of 4, with none given a score of 5. The fact that nearly two thirds of the recommendations (64%) were rated a 1 or 2 indicates that the large majority were regarded by the project team as having high value and likely to achieve a substantial impact.

See Table 3 on the next page

Table 3. Recommendations: Summary of results by major element

ELEMENT								
TIER	RANK SCORE	Inputs	Activities	Outputs	Intermediate Outcomes	End Outcomes	Impacts	Totals
		Number of recommendations and/or metrics in each element						
I	1	19	8	8	7	1	3	46
	2	6	27	4	1	0	0	38
	3	17	14	5	3	0	0	39
	4	2	3	0	0	0	0	5
	5	0	0	0	0	0	0	0
II	1	4	0	4	1	4	1	14
	2	10	6	10	1	0	3	30
	3	9	6	8	3	0	0	26
	4	3	0	0	1	0	0	4
	5	0	0	0	0	0	0	0
III	1	4	0	0	0	0	0	4
	2	5	1	8	1	0	0	15
	3	3	1	2	1	0	0	7
	4	1	2	0	1	0	0	4
	5	0	0	0	0	0	0	0
Totals		83	68	49	20	5	7	232

Distilling the complete set of 232 recommendations into their common denominators resulted in the following 10 major recommendations. These ten recommendations embody the essence of the DoD T2 Impact Model. Each is a composite of one or more (often many) of the 232 specific recommendations generated by the project. Together, they represent the major reforms necessary to enable the DoD T2 system to realize its potential and have a major impact on the defense mission and national economy. They will guide DoD decision-makers in implementing the DoD T2 Impact Model. However, the complete list of 232 recommendations will provide the specific ideas or ideas to inform this implementation.

Ten Major Recommendations to Improve the DoD T2 System

1) Develop and deploy a strong DoD T2 strategy that extends from initial inputs to the desired end results, seamlessly integrates T2 with technology transition, focuses on achieving substantial impacts on the defense mission, and employs robust metrics throughout to help ensure the success of this strategy.
2) Provide sufficient resources (including personnel and funding) to enable all DoD labs to effectively conduct their legally mandated and DoD required IP protection and T2 functions in support of the defense mission.
3) Educate and train relevant DoD personnel (T2 and legal staff, S&Es, lab leaders, acquisition program managers, and DoD policymakers) so they understand the importance of IP protection and T2 to the defense mission, comprehend the legal requirements for these activities, strongly support them, and can effectively participate in achieving their success.
4) Establish mechanisms and metrics to enable DoD to effectively track and evaluate its T2 operations from initial inputs to final results, including the ultimate impacts of DoD license agreements and CRADAs on the defense mission.
5) Motivate S&Es and lab leaders to fully support IP protection, T2, and technology transition by providing the necessary incentives, training, funding, and assistance and by annually evaluating these personnel on participation in these activities.
6) Streamline T2 procedures at all DoD labs (including training, invention disclosure, and agreement-related processes) by implementing best practices and establishing standardized, business-friendly CRADA and license agreement templates, to make it quicker, easier, and more cost-effective for DoD labs and industry to engage in T2 partnerships.
7) Equip all DoD labs with a robust T2 management system to facilitate and automate IP- and T2-related activities—from initial invention disclosures and patent docketing, through technology marketing and T2 agreement generation, to patent and license management and royalty distribution to inventors.
8) Effect changes to substantially increase the use of T2 to achieve transition of new technology to the U.S. Warfighter, recognizing that this is a cost-effective, underutilized way to enable DoD to benefit from innovations emerging wholly or partly from its own R&D labs.
9) Establish strong, user-friendly mechanisms to identify and transition critically needed DoD-developed or co-developed technologies to acquisition programs via the T2 pathway, providing the necessary funding and using standardized TTAs and accelerated acquisition authorities as much as possible.
10) Develop and implement an effective communication strategy to tell the story of how, through technology transfer, the DoD laboratory system benefits the defense mission, national economy, and American public.

Highly Recommended New Metrics for the DoD T2 System

The project generated a total of 44 proposed new metrics for consideration by DoD policymakers. The TechLink team assigned a top score (rank of "1") to 28 of these metrics. These highly recommended new metrics are featured in Figure 25. The other 16 metrics included in the complete list of recommendations should also be considered for adoption, either by DoD as a whole or by individual DoD labs.

All except four of the 28 metrics in Figure 25 are Tier I recommendations. This indicates they are regarded as low-to-no cost solutions that DoD could readily implement without needing additional funding or policy changes. The remaining four metrics, denoted by the "(II)" symbol, are considered Tier II recommendations, meaning they would likely require some additional funding and/or policy changes to implement. All 28 metrics are intended as additions to the existing metrics in the DoD T2 system, which have previously been discussed and are expected to be retained.

See Figure 25 on the next page

The complete list of 232 recommendations and metrics is presented in Appendix 7.

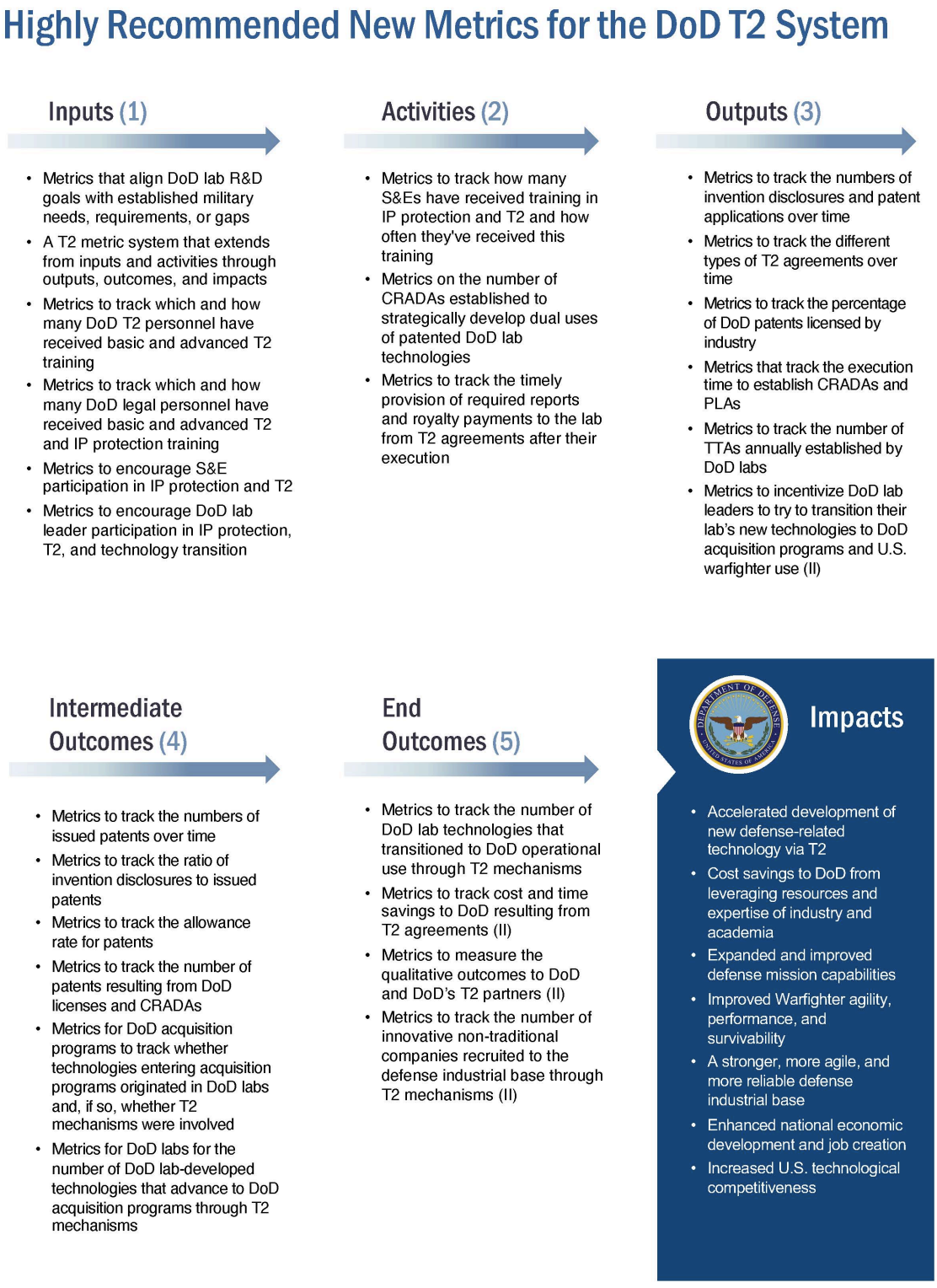
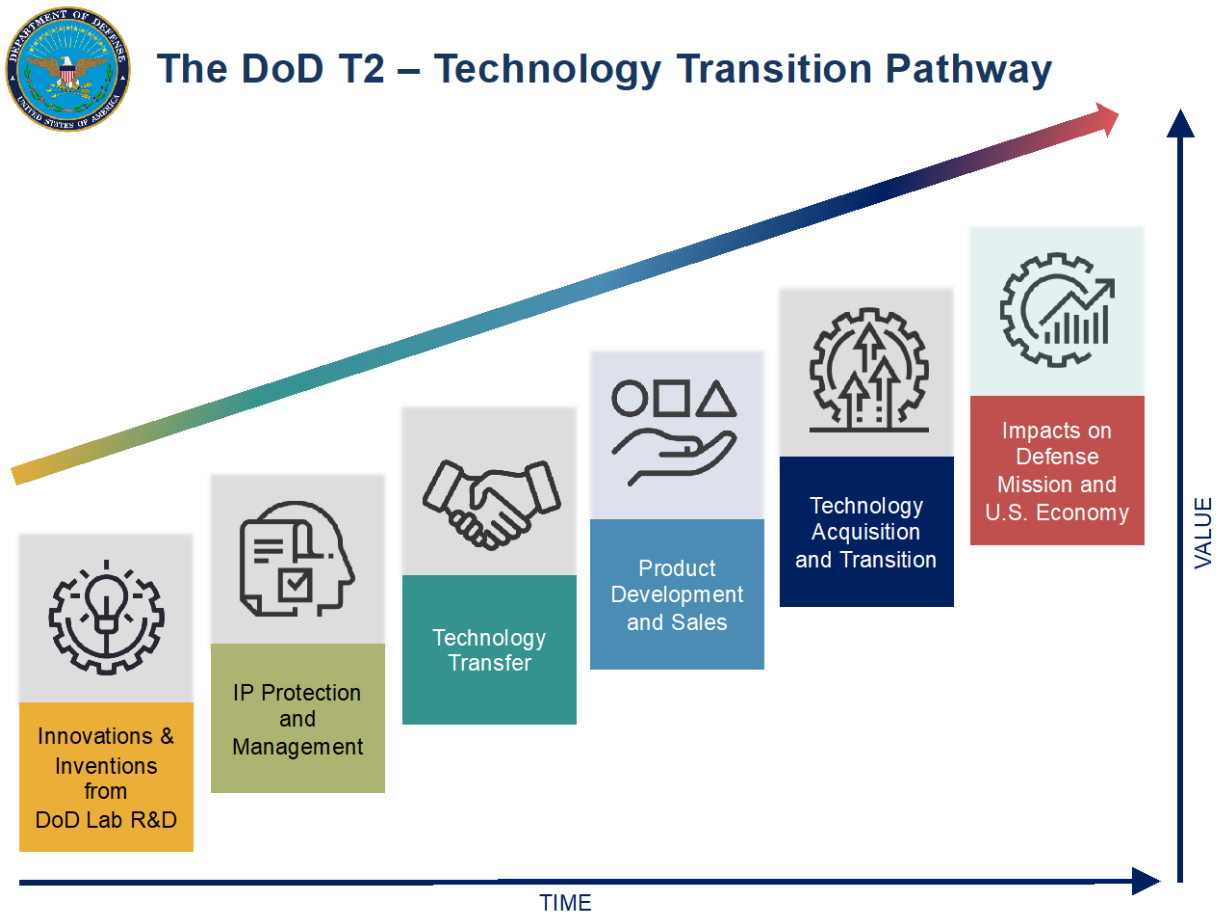


Figure 25. Highly Recommended New Metrics for the DoD T2 System

Conclusion

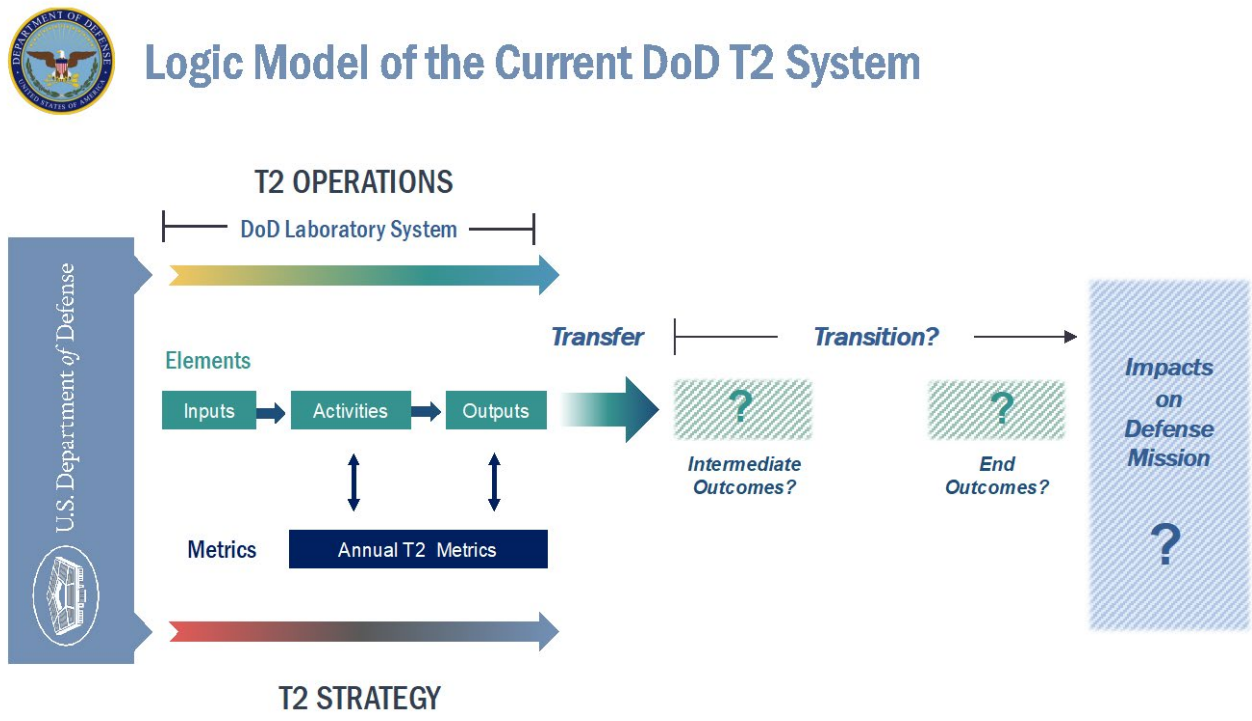
This study analyzed the current DoD T2 system, diagnosed its shortcomings, and developed a model of an improved T2 system. The study focused on **all key stages of the DoD T2 – Technology Transition Pathway**. As the graphic below shows, these stages extend from initial R&D within the DoD lab system to identifying, protecting, and managing new DoD-developed inventions; establishment of license agreements to transfer DoD inventions to companies or of CRADAs to co-develop new technologies with industry; conversion by industry of the DoD-developed or co-developed technologies into new commercial, dual-use, or military products and services; acquisition and transition of T2-related products and services to DoD operational use; and realization of the ultimate impacts of these products and services on the defense mission and U.S. economy.



The study involved **five separate tasks:** a thorough literature review to identify publications with information or insights that could assist in realizing the project objectives; 200 interviews with DoD and private-sector personnel; construction of a logic model of the current T2 system highlighting shortcomings in its inputs, activities, outputs, outcomes, and impacts; development of a logic model of an improved DoD T2 system designed to increase this system's impacts on the defense mission and U.S. economy; and formulation of a comprehensive set of recommendations and new metrics to assist in implementing the new system.

The research team's in-depth interviews with both DoD and private-sector personnel revealed major shortcomings in all elements of the current DoD T2 system. These shortcomings extend all the way from the initial inputs through the activities, outputs, outcomes, and impacts.

As the following graphic shows, DoD's T2 operations are highly circumscribed in both their scope and strategic vision. They are widely perceived to include only T2-related inputs, activities, and outputs. These operations essentially end with the T2 events themselves, such as the execution of a license agreement or completion of a CRADA project.



Metrics used to evaluate these operations focus almost exclusively on activities and outputs. These metrics include the numbers of invention disclosures, patent applications, issued patents, license agreements, and CRADAs. Except for measuring royalties and other licensing income, DoD's current T2 metrics do not extend to the outcomes and impacts. TechLink's economic impact studies provide a periodic, high-level estimate of DoD T2's impact on the national economy as well as of sales of T2-related products to the U.S. military. However, the current DoD T2 system does not otherwise attempt to track the outcomes and impacts from its T2 operations.

In the current DoD T2 system, the strategic vision of T2 basically stops at the DoD lab gates. The basic strategic goal is generating T2 agreements. There is no explicit strategy with concrete steps, milestones, and metrics to enable the T2 system to achieve an impact on the defense mission. In fact, there are only tenuous links between DoD's T2 operations and its technology transition programs, with relatively few resources devoted to delivering DoD lab inventions to the U.S. Warfighter. As a result, DoD's T2 operations as well as the DoD lab system fall substantially short of having a major impact on the defense mission.

Notable shortcomings in the current DoD T2 system include:

- Inadequate staffing and funding
- Inadequate training
- Weak support from DoD leadership
- Inadequate disclosure of inventions by S&Es
- Low numbers of patent applications and issued patents relative to DoD's total R&D expenditures
- Inadequate marketing of T2 opportunities, particularly of CRADA opportunities
- Lack of standardized and streamlined T2 agreements across DoD
- Inconsistent monitoring and management of DoD IP and T2 agreements after execution
- Lack of procedures and metrics to track the outcomes of completed T2 agreements
- Inadequate communication and coordination between DoD labs and acquisition programs
- Low use of TTAs to facilitate transition of DoD lab-developed or co-developed technologies to U.S. Warfighter use
- Lack of funded mechanisms to transition DoD lab technologies to DoD operational use.

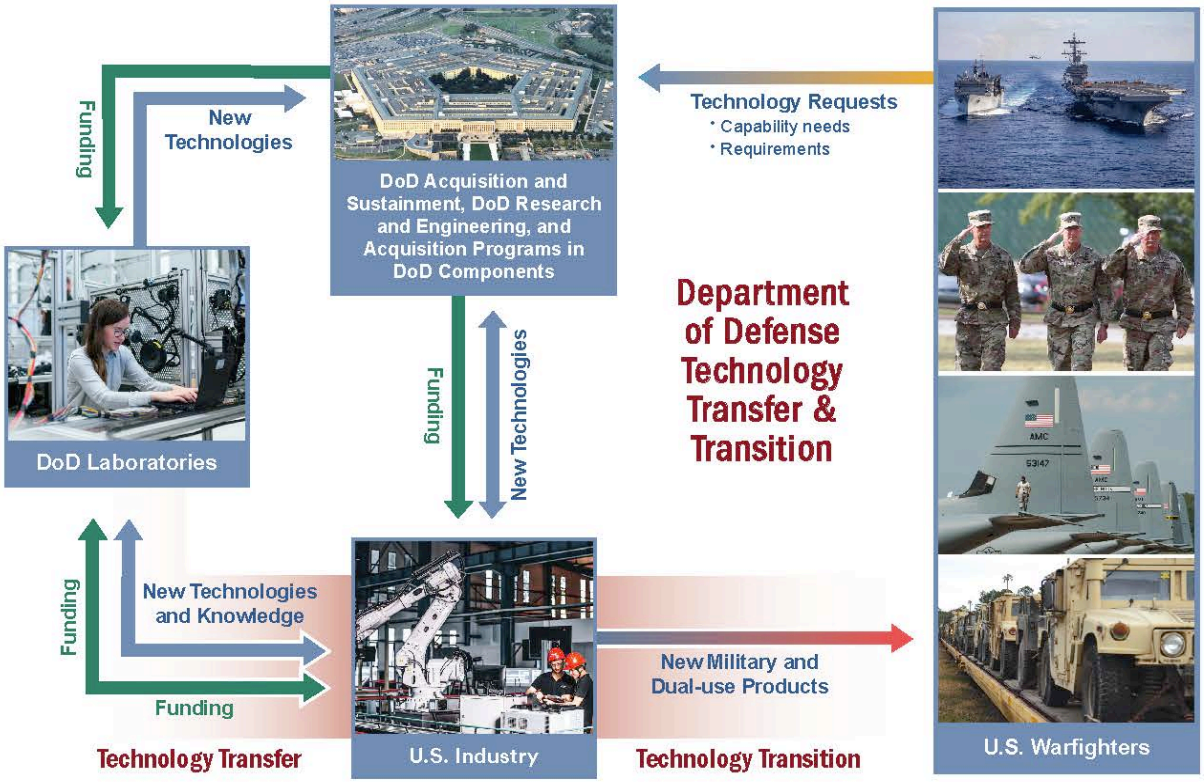
As a result, there are relatively few documented cases of DoD lab-developed technologies in DoD operational use. In addition, DoD fails to fully leverage available expertise in U.S. industry and academia in developing new defense-related technologies. It also fails to benefit from many cutting-edge technologies developed in the private sector that could meet critical military needs (including those commercialized by its T2 partners or DoD SBIR-funded small technology firms). Finally, under the current DoD T2 system, there is weak recruitment of innovative companies to the defense industrial base—both major corporations and small technology firms that are not currently defense contractors.

Technology transition in the current DoD system rarely involves the use of T2 mechanisms. In fact, it is even poorly understood within DoD that T2 is an important pathway to achieve technology transition to U.S. military use.

The graphic below depicts the two major pathways by which new technology is transitioned to the U.S. Warfighter. The primary pathway (the middle and lower right arrows in the diagram) involves DoD acquisition programs contracting directly with U.S. industry—usually with major defense firms. These

traditional defense contractors either develop and/or manufacture the desired new technology after a successful contract bid or develop it through their own independent R&D programs and subsequently sell the resulting products to DoD acquisition programs for deployment by U.S. forces. While this pathway may involve R&D assistance from DoD lab S&Es, it rarely involves technology transfer.

The T2 pathway is the second way that new technology transitions to Warfighter use. This pathway involves direct interactions between DoD labs and U.S. industry (the lower left, middle, and lower right arrows). It previously was fully illustrated in the “DoD T2 – Technology Transition Pathway” graphic.



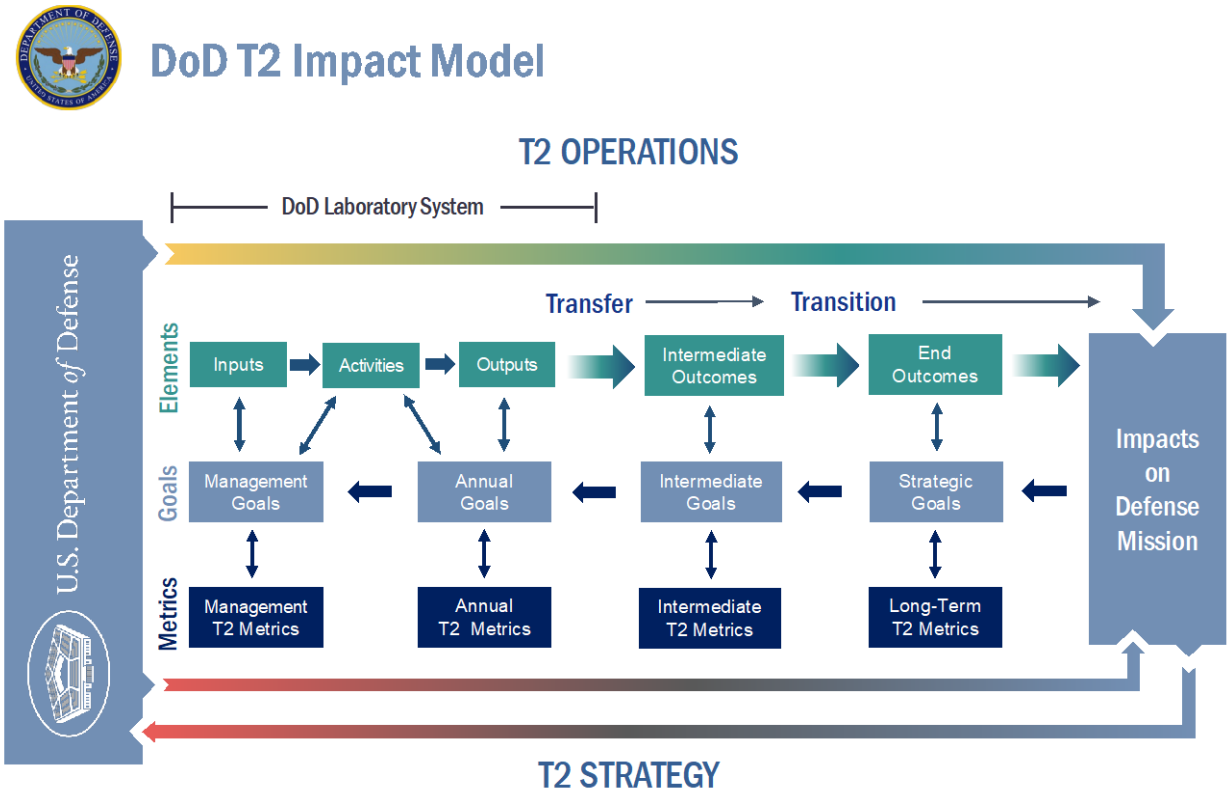
DoD Technology Transfer and Transition

The T2 pathway to transition is greatly underutilized and frequently ignored. Using this path, companies license DoD inventions from DoD labs, co-develop new technology with DoD labs under CRADAs, or develop specified technologies under competitive SBIR contracts. If all proceeds well, these companies convert the technologies into commercial and/or defense-related products, which they can then sell to DoD acquisition programs for U.S. military use. Virtually none of these companies are traditional defense contractors.

For technology transition to occur through the T2 pathway, DoD’s license, CRADA, or SBIR partners need to make DoD acquisition programs aware of their products and motivated to procure them. This is usually a heavy burden. Because few of these companies are traditional defense contractors, they do not

understand how to sell to DoD. Also, there are relatively few DoD programs to assist them. As a result, the U.S. defense mission usually does not benefit from technologies developed or co-developed in DoD's own labs or with DoD SBIR funding.

The DoD T2 Impact Model shown in the following graphic was designed to overcome the shortcomings of the current DoD T2 system. In addition, it was designed to substantially increase the importance of the T2 pathway to achieve technology transition, so DoD can fully benefit from innovations emerging from its own laboratory system.



The DoD T2 Impact Model embodies a major paradigm shift in how technology transfer is viewed. In contrast to the current system, where T2 operations are perceived to end at the point of transfer, in the new model, T2 operations extend all the way to the ultimate impacts on the defense mission. In essence, DoD T2 is re-imagined and re-engineered to become one of DoD's most important transition programs.

The DoD T2 Impact Model accomplishes several important goals. It enables DoD leaders to track DoD lab inventions and T2 agreements to their ultimate outcomes, so they can evaluate the impact of DoD lab R&D and T2 operations on the defense mission. It also enables DoD leaders to develop a comprehensive T2 strategy. Starting with the desired impacts on the defense mission, they can reverse-engineer the necessary strategic goals, intermediate goals, annual goals, and initial management goals necessary for an effective T2 strategy. The model helps DoD leaders ensure that DoD's T2 operations are completely aligned with its T2 strategy. It also seamlessly connects DoD T2 to technology transition in an overall effort

to deliver innovative technology to the U.S. Warfighter. Finally, it incorporates metrics for each stage in the T2 process to help achieve the desired outcomes and impacts.

Features of the proposed improved DoD T2 system include:

- A strong T2 strategy focused on impacts on the defense mission
- Established and fully documented T2 policies and procedures at all DoD labs
- Sufficient staffing and funding for DoD's T2 function
- Adequate IP protection and T2 training for T2 personnel, legal staff, S&Es, lab leaders, and the acquisition community
- Strong support for IP protection, T2, and technology transition from DoD leadership
- Substantially increased disclosures of inventions by S&Es
- Increased numbers of patent applications and issued patents
- Stronger lab marketing to industry of CRADA and licensing opportunities
- Standardized, streamlined, business-friendly T2 agreements across DoD
- Substantially increased numbers of license agreements and CRADAs
- Established metrics that measure inputs, outcomes, and impacts, not just activities and outputs
- Robust proactive monitoring and management of DoD IP and T2 agreements
- Strong communication and coordination between DoD labs and acquisition programs
- Strong funded processes to transition DoD lab technologies to DoD operational use
- Established procedures and metrics to track the outcomes and impacts of completed T2 agreements.

The **recommendations and metrics** accompanying the DoD T2 Impact Model are designed to help DoD policymakers implement the DoD T2 Impact Model. These recommendations are organized and prioritized in four different ways. *First*, they are grouped according to the element in the T2 system to which they pertain—inputs, activities, outputs, intermediate outcomes, end outcomes, or impacts. *Second*, they are sorted into three different tiers, each tier indicating the relative difficulty of implementation. *Third*, they are ranked with scores from 1 to 4 to indicate the anticipated benefit from their implementation (no recommendations were assigned a score of "5"). *Fourth,* they are assigned labels to indicate which of the following six functional categories they address: strategy and policies; resources; education and training; processes and procedures; acquisition; or metrics.

The project generated a total of 232 specific recommendations for consideration by DoD policymakers, including 44 proposed new metrics. Of these, 64 recommendations (including 28 new metrics) were given a top score of 1. These are the recommendations that the project team believes will have the greatest impact on the DoD T2 system.

Distilling the 232 recommendations into their common denominators resulted in a final set of **10 major recommendations**—essentially the *major reforms* necessary for the DoD T2 system to achieve its full

potential and have a substantial impact on the defense mission and national economy. These ten embody the essence of the DoD T2 Impact Model and recommendations generated by the project. They will guide DoD decision-makers in implementing the DoD T2 Impact Model. However, the complete set of 232 recommendations will provide the specific ideas needed to inform this implementation. The ten major recommendations follow:

1) Develop and deploy a strong DoD T2 strategy that extends from initial inputs to the desired end results, seamlessly integrates T2 with technology transition, focuses on achieving substantial impacts on the defense mission, and employs robust metrics throughout to help ensure the success of this strategy.
2) Provide sufficient resources (including personnel and funding) to enable all DoD labs to effectively conduct their legally mandated and DoD required IP protection and T2 functions in support of the defense mission.
3) Educate and train relevant DoD personnel (T2 and legal staff, S&Es, lab leaders, acquisition program managers, and DoD policymakers) so they understand the importance of IP protection and T2 to the defense mission, comprehend the legal requirements for these activities, strongly support them, and can effectively participate in achieving their success.
4) Establish mechanisms and metrics to enable DoD to effectively track and evaluate its T2 operations from initial inputs to final results, including the ultimate impacts of DoD license agreements and CRADAs on the defense mission.
5) Motivate S&Es and lab leaders to fully support IP protection, T2, and technology transition by providing the necessary incentives, training, funding, and assistance and by annually evaluating these personnel on participation in these activities.
6) Streamline T2 procedures at all DoD labs (including training, invention disclosure, and agreement-related processes) by implementing best practices and establishing standardized, business-friendly CRADA and license agreement templates, to make it quicker, easier, and more cost-effective for DoD labs and industry to engage in T2 partnerships.
7) Equip all DoD labs with a robust T2 management system to facilitate and automate IP- and T2-related activities—from initial invention disclosures and patent docketing, through technology marketing and T2 agreement generation, to patent and license management and royalty distribution to inventors.
8) Effect changes to substantially increase the use of T2 to achieve transition of new technology to the U.S. Warfighter, recognizing that this is a cost-effective, underutilized way to enable DoD to benefit from innovations emerging wholly or partly from its own R&D labs.
9) Establish strong, user-friendly mechanisms to identify and transition critically needed DoD-developed or co-developed technologies to acquisition programs via the T2 pathway, providing the necessary funding and using standardized TTAs and accelerated acquisition authorities as much as possible.
10) Develop and implement an effective communication strategy to tell the story of how, through technology transfer, the DoD laboratory system benefits the defense mission, national economy, and American public.

Implementation of the DoD T2 Impact Model and accompanying recommendations can be immediately initiated but will take several years to fully accomplish. As Table 4 shows, it should be feasible to implement Tier I recommendations—the low-to-no-cost solutions—during the first two years. Tier II recommendations, which require some additional funding and/or policy changes, could realistically take two to three years to execute. Finally, Tier III recommendations, which necessitate substantial additional funding and policy changes, may take three or more years to fully implement. Table 4 shows a notional schedule for implementation of the DoD T2 Impact Model and associated recommendations.

Table 4. Notional Implementation Schedule for the DoD T2 Impact Model

DoD T2 Model Implementation Schedule					
	Years				
Recommendations by Tier	1	2	3	4	5
TIER I: Low-to-no-cost solutions that can be readily and immediately implemented					
TIER II: Solutions that will require some additional funding and/or policy changes					
TIER III: Solutions that will require substantial additional funding and policy changes					

Anticipated results

Anticipated results from implementation of the DoD T2 Impact Model and associated recommendations include:

- Increased engagement of U.S. industry and academia in developing new defense-related technologies, with associated cost savings
- An increased number of new products resulting from DoD T2 agreements
- DoD T2 becoming a major pathway to achieve technology transition
- A substantial increase in DoD lab technologies being transitioned to DoD programs of record and operational use
- More frequent spin-in of cutting-edge technologies developed in the private sector
- Increased recruitment of innovative companies to the defense industrial base, including major corporations and small technology firms that are not currently defense contractors.

Major impacts

Major impacts will include:

- Accelerated development of new defense-related technology
- An increased stream of innovative technology to the U.S. Warfighter
- Expanded defense mission capabilities
- A stronger, more diversified, and more agile defense industrial base
- Enhanced national economic development
- Increased U.S. technological competitiveness.

Appendices

Appendix 1: Research Team

The TechLink team conducting this project consisted principally of the following five T2 professionals. Collectively, these team members have more than 100 years of hands-on experience with DoD technology transfer.

Will Swearingen, PhD, Project Manager

Dr. Will Swearingen led this research project and was the principal author of the final report. In addition, he interviewed the personnel at DoD's independent defense agencies, supervised a team of TechLink economic researchers for the interviews of company executives, and personally conducted approximately a fourth of the company interviews. Dr. Swearingen is currently the Director of Special Projects and Senior Advisor at TechLink. In that position, he has overseen other major projects such as developing a new T2 Handbook for the Air Force and a New ORTA Guide for the Navy. In addition, he advises TechLink on its economic impact studies. He has written eight published articles on DoD T2 and SBIR, the majority in peer-reviewed publications. Dr. Swearingen helped to found TechLink in 1996 and, while serving as its Executive Director from 2000 to 2018, played a key role in transforming TechLink into a nationally recognized T2 center. He has extensive, hands-on experience brokering T2 agreements for both DoD and NASA and is a Certified Licensing Professional (CLP). Overall, he has been closely involved with DoD T2 for over 23 years. Dr. Swearingen has a PhD in geography from the University of Texas at Austin and an MA in geography from Durham University, England. He was a postdoctoral fellow at Stanford University under a fellowship from the John D. and Catherine T. MacArthur Foundation.

Austin Leach, PhD, Project Advisor

Dr. Austin Leach helped guide this project and was closely involved in the review of the final report. Dr. Leach is TechLink's Associate Director. In that position, he leads TechLink's T2 initiatives for both DoD and the Department of Veteran's Affairs, with a strong focus on technology evaluation, marketing, and licensing. In addition, he specializes in brokering license agreements for DoD inventions in the areas of advanced materials and nanotechnology. Prior to joining TechLink in 2014, Dr. Leach spent six years in medical device R&D with Abbott Laboratories, a Fortune 500 company, developing new materials for cardiovascular implants and next-generation continuous glucose monitoring systems for diabetes management. During his time at Abbott, he became an inventor on four patents issued by the U.S. Patent and Trademark Office. Dr. Leach has BS and MS degrees in Mechanical Engineering from Mississippi State University and a PhD in Materials Science and Engineering from the Georgia Institute of Technology. He is a Certified Licensing Professional (CLP).

Kristen Schario, Air Force T2 Specialist

Kristen Schario interviewed the Air Force personnel, helped evaluate the project recommendations, and reviewed the final report. Ms. Schario is one of the foremost experts in Air Force technology transfer, with over 31 years of experience, including 28 years as an Air Force employee and four years working for TechLink. She began her career in 1985 as a mechanical engineer in the Aerospace Power Division of the

Air Force's Propulsion Laboratory. Subsequently, she was promoted to staff engineer in the recently created Propulsion Directorate in 1989, then became the head of its T2 office in 1991. When the Air Force Research Laboratory (AFRL) system was created in 1997, Ms. Schario was promoted to Senior Staff Engineer and T2 Manager for the Propulsion Directorate. As Senior Staff Engineer, she managed several different R&D programs. When Propulsion was merged with Air Vehicles in 2012 to create the new Aerospace Systems Directorate, Ms. Schario was appointed manager of its Office of Research and Technology Applications. She held that position until retiring from the Air Force in October 2018. In recognition of her outstanding accomplishments in DoD T2, she was selected to receive the prestigious national George Linsteadt Technology Transfer Award in 2016. Since April 2019, Ms. Schario has been a part-time employee of TechLink, where she played a lead role in creating a new T2 Handbook for the Air Force. She has a BS degree in Mechanical Engineering from the University of Akron, Ohio.

Chris Root, Navy T2 Specialist

Chris Root interviewed the Navy personnel, helped evaluate the project recommendations, and reviewed the final report. Chris Root's credentials include 33 years of demonstrated technical leadership in the areas of T2 and engineering innovation at NAVAIR's Fleet Readiness Center Southwest (FRCSW) in San Diego, CA. This experience includes 12 years as the Advanced Technology & Innovation Team Lead and 10 years as the head of the Office of Research and Technology Applications. In fact, Mr. Root petitioned for FRCSW to become designated as a federal lab and was selected by the Commanding Officer to serve as that lab's first ORTA in 2010. In his decade in that position, he creatively used various T2 mechanisms to develop and evaluate new technology to help FRCSW achieve its mission—maintenance, repair, and overhaul of the Navy and Marine Corps' aircraft to increase their reliability and improve their readiness level. Since retiring from the Navy, Mr. Root has been a part-time employee of TechLink. In that capacity, he helped TechLink develop a New ORTA Guide for the Navy. He has a BS degree in Aerospace Engineering from San Diego State University.

Russ Alexander, PhD, Army T2 Specialist

Dr. Russ Alexander interviewed the Army personnel, helped evaluate the project recommendations, and reviewed the final report. Dr. Alexander has over 25 years of hands-on experience in DoD technology transfer. From 1991 to 2000, he led the T2 program for the U.S. Army Space and Missile Defense Command. Subsequently, from 2000 to 2006, he managed the SBIR/STTR program at the Missile Defense Agency. Then, from 2006 to 2017, he was the T2 head for the U.S. Army Aviation and Missile Research Development and Engineering Center (AMRDEC). Since his retirement from the Army in 2017, Dr. Alexander has served as a contractor for TechLink, brokering T2 agreements between the Army and private industry. He holds a BSE in Chemical Engineering from the University of Mississippi, an MS in Business Administration from Texas A&M University-Texarkana, an MSE in Industrial and Systems Engineering from the University of Alabama in Huntsville, and a PhD in Operations Research from the University of South Africa, Pretoria. Dr. Alexander is a licensed professional engineer (PE) in the state of Alabama.

Appendix 2. Project Schedule by Task

Tasks and Associated Activities	QUARTER						
	Q4 FY21 Summer	Q1 FY22 Fall	Q2 FY22 Winter	Q3 FY22 Spring	Q4 FY22 Summer	Q1 FY23 Fall	Q2 FY23 Winter
Identify and analyze relevant studies and reports							
Interview DoD and private sector personnel							
Develop and conduct initial interviews							
Conduct follow-up interviews							
Analyze data from interviews							
Develop logic model of current DoD T2 system							
Develop new DoD T2 Impact Model							
Formulate recommendations and metrics							
Draft and deliver final report							

Appendix 3: Complete Literature Review

For this project, TechLink conducted a focused, thorough review of the existing English-language literature on technology transfer to glean information and insights that could help achieve the project objectives. This review focused primarily on publications in the United States appearing between roughly 2000 and the present. It examined both the academic and government policy-oriented literature. The former consists mainly of peer-reviewed articles in scholarly journals; the latter of reports from studies conducted or commissioned by the U.S. federal government.

Relevant publications were identified, in part, through extensive online research using various search engines such as Google Scholar as well as the Montana State University Library "Articles and Research Database" collection, which consists of over 240 databases covering approximately 100,000 scholarly journals and other periodicals. In addition, pertinent government reports were identified using specialized U.S. government search engines such as *gao.gov* and the website of the Institute for Defense Analyses, *ida.org*. This online research employed combinations of the following keywords and terms: *federal laboratory, university, technology transfer, licenses, patents, CRADAs, models,* and *metrics.* The research team also directly consulted the references cited in recent comprehensive literature reviews focusing on federal agency T2 (e.g., Peña and Novak 2021; Peña and Mandelbaum 2020; and Link et al. 2019) to identify relevant publications.

Using these search methods, the project team was able to identify approximately 50 publications that appeared to be directly relevant and potentially helpful. These publications were carefully reviewed for information and insights that could help guide the project and assist in the development of a robust DoD T2 Impact Model.

The literature review revealed a surprising lack of publications on practical steps that U.S. federal agencies can take to improve their T2 processes and metrics. In fact, compared to the literature on university T2, relatively little has been written about U.S. federal agency T2 (Peña and Mandelbaum 2020; Choudhry and Ponzio 2020; Link et al. 2019; Bozeman et al. 2015; and Bozeman 2013).

This review revealed that most of the academic, peer-reviewed T2 literature focuses on university technology transfer and ignores federal laboratories. Choudhry and Ponzio (2020) and Bozeman (2013) attribute this to the relative lack of publicly available, agency-specific information on federal laboratory T2 outcomes compared to the plethora of data on U.S. and Canadian universities compiled by the Association of University Technology Managers (AUTM).

In addition, most of the academic, peer-reviewed literature was found to be theoretical or conceptual rather than practical in nature. Authors typically were social scientists who were striving to better understand technology transfer rather than trying to offer actionable improvements. Many of these authors evinced little practical understanding of technology transfer, particularly of federal agency T2.

Academic journal articles focusing on federal T2 were frequently found to present conclusions that are already well understood among T2 professionals, not grounded in operational reality, simply naïve, or merely common sense.

For example, Leech and Scott, when examining whether federal agencies should pursue foreign patent protection for their inventions, argued that by increasing their numbers of foreign patents, federal agencies would increase their numbers of license agreements and the resulting licensing revenues. For DoD specifically, they conclude that each foreign patent would generate at least $2,318,129 in additional licensing royalties (Leech and Scott 2021a).

Leech and Scott's conclusions are based on the observation that federal agencies with a larger number of foreign patents generate larger licensing revenues than agency portfolios with fewer foreign patents. The authors seem to assume that there is a cause-and-effect relationship between possession of foreign patents and the commercial success of the patented inventions. This ignores the fact that most of the royalties in any patent portfolio—federal agency or university—are generated by a few highly successful inventions for which foreign patent protection was sought specifically because of their perceived high international commercial potential. Further, it assumes that federal labs have an unlimited budget to pursue foreign patent protection (which can run into hundreds of thousands of dollars for a single invention).

"Academic journal articles focusing on federal T2 were frequently found to present conclusions that are already well understood among T2 professionals, not grounded in operational reality, simply naïve, or merely common sense."

Most DoD labs rarely pursue foreign patent protection because relatively few DoD inventions have high commercial viability. DoD seeks patents for many reasons, including to prevent defense contractors from claiming these inventions and charging DoD for their use; to protect itself against claims of infringement; and to recognize the achievements of its scientists and engineers. The authors' conclusion that each foreign patent would generate at least $2.3 million in additional licensing revenues for DoD is frankly absurd. In fact, an estimated 75% of DoD's royalties over the past two decades derive from the licensing of a single *unpatented* monoclonal antibody by the Uniformed Services University of the Health Sciences (USUHS).

With only a few exceptions, almost none of the academic literature was written by T2 professionals with the goal of improving federal agency T2 processes.

With only a few exceptions, almost none of the academic literature identified was written by T2 professionals with the goal of improving federal agency T2 processes. One exception was the study by Choudhry and Ponzio (both T2 professionals), which proposed two new metrics designed to improve assessing the effectiveness and return on investment (ROI) of federal agency T2 programs (Choudhry and Ponzio 2020). Another exception was the study analyzing the factors affecting the time required to establish CRADAs in federal labs, on which Choudhry and Ponzio were co-authors (Ravilious et al. 2021).

The government policy-oriented literature was more directly relevant. The project team identified several dozen reports from studies on federal agency T2 that were commissioned or conducted by the U.S. government. The explicit purpose of virtually all these studies was to evaluate the success of federal agency T2 or to recommend steps that agencies could take to improve their T2 processes.

Some of these reports resulted from research conducted by federal agencies themselves, including the U.S. General Accounting Office (GAO), which functions as the investigative arm of Congress; the National Institute of Standards and Technology (NIST), which serves as the coordinating entity for federal agency T2 across the U.S. government; and the White House's Office of Science and Technology Policy (OSTP). A few of the reports were written by academic researchers under government contract, who applied the theoretical or conceptual approaches they use to study university T2 to federal agency T2 (e.g., Hasik et al. 2022, Link et al. 2019, Pressman et al. 2018, and Bozeman 2013). The remainder of these reports resulted from studies by specialized nonprofit entities under commission from federal agencies. These include the Science and Technology Policy Institute (STPI), which is operated by the Institute for Defense Analyses (IDA); the RAND Corporation; and TechLink.

The majority of these government reports examined general problems and issues in T2 across the federal government (e.g., GAO 2018; Link et al. 2019; Peña et al. 2017; and Lal et al. 2012). For example, the GAO (2018) focused on federal agency challenges in licensing their patented inventions. These challenges include getting federal lab researchers to identify potentially patentable inventions, the lack of effective systems to monitor lab inventions and license agreements, licensing processes that are perceived as lengthy and bureaucratic by industry, and labs' lack of understanding of how to establish reasonable licensing terms.

A substantial number of these government reports were written in response to the influential 2011 Presidential Memorandum, "Accelerating Technology Transfer and Commercialization of Federal in Support of High Growth Businesses" (White House Research 2011). This memorandum tasked federal agencies with establishing goals and metrics to improve their T2 performance: "Agencies with Federal laboratories shall develop plans that establish performance goals to increase the number and pace of effective technology transfer and commercialization activities in partnership with non-federal entities..." (White House 2011). This memorandum also directed the federal government's Interagency Workgroup on Technology Transfer to make recommendations on ways to improve federal agency T2, including "new or creative approaches to technology transfer that might serve as model programs for Federal laboratories...and criteria to assess the effectiveness and impact on the Nation's economy of planned or future technology transfer efforts" (White House 2011).

> Many U.S. government reports that examined federal agency T2 were written in response to the influential 2011 Presidential Memorandum, which tasked federal agencies with establishing goals and metrics to improve their T2 performance.

Government reports conducted in response to this Presidential Memorandum included NIST 2013; Howieson et al. 2013a; Howieson et al. 2013b; OSTP 2013; NIST 2013; and Bozeman 2013. For example, the 2013 OSTP report presented the findings of a panel of experts at a "Lab-to-Market Inter-Agency Summit" convened by the White House to improve the commercialization of federally funded research and development. This report cautioned that most federal lab inventions will not become commercialized because, even in the private sector, only a small percentage of internal research projects eventually result in new products. In addition, the report recognized that many federal agencies (such as DoD) focus most of their research on mission needs. As a result, "it is not reasonable to impose on federal agencies the same kind of return-on-investment metrics used by industry" (OSTP 2013, p. 6).

Many of the recommendations to improve federal T2 in these Presidential Memorandum-related reports were overly general and offered only common-sense suggestions, such as that the government should work "to reduce the time to complete agency partnership and licensing agreements with industry" (OSTP

2013, p. 9). The same is true for most of the recommendations in the other government reports previously cited. Furthermore, most of these reports focused on T2 across the entire federal laboratory system. As a result, most were of limited utility to this project.

Three of the reports commissioned following the 2011 Presidential Memorandum focused specifically on how DoD could improve its T2 operations (Howieson 2013a; Howieson 2013b; Gonsalves 2012). All three relied on interviews with DoD T2 personnel and stakeholders as their primary data-collection method. Although now a decade old, all three contain suggestions that are still timely and directly relevant. The first (Howieson 2013a), highlighted 24 "exemplar" DoD T2 practices that had demonstrated significant measurable outputs, outcomes, or other results. The second (Howieson 2013b), addressed 15 different T2 policy issues and came up with a multitude of interviewee concerns and specific recommendations to address these concerns and improve DoD T2. The current project's interviews exposed many of the same policy issues and concerns. The third (Gonsalves 2012), analyzed the Navy's use of T2 mechanisms and offered recommendations on how it could more effectively use these mechanisms to advance Navy lab innovations into Navy acquisition programs.

"The most helpful resources identified for this project were the relatively few government reports and academic articles that provided an in-depth focus on T2 metrics, models, or impacts."

The most helpful resources identified for this project were the relatively few government reports and academic articles that provided an in-depth focus on T2 *metrics*, *models*, or *impacts*. These include Peña and Novak 2021; Peña et al. 2021; Peña and Mandelbaum 2020; Landree and Silberglitt 2018; Luna 2021; TechLink 2022, 2019a, 2019b, 2016, and 2013; Pressman et al. 2018; Roessner et al. 2013; and Bozeman 2013).

Metrics

Most of the T2 metrics used today by both federal agencies and universities date back to the 1980s. The modern T2 system in the United States resulted from landmark Congressional legislation during that decade—notably the Stevenson-Wydler and Bayh-Dole Acts of 1980 and the 1986 Federal Technology Transfer Act (FTTA). These influential legislative acts established T2 as a key activity of both federal laboratories and universities and fostered the creation of a strong national T2 infrastructure. Prior to 1980, very few T2 offices existed in the United States. However, by the end of the 1980s, nearly all federal labs and universities had T2 offices and were actively engaged in technology transfer with the private sector.

Simultaneously, during the 1980s, there was strong Congressional pressure for greater accountability to ensure that federal R&D funding was contributing to national technological competitiveness and economic growth. As a result, one of the most important functions of the hundreds of new T2 offices was to gather and report statistics on their T2 activities.

The 1986 FTTA mandated that federal agencies with one or more R&D laboratories provide an annual report on their T2 activities for submission to Congress and the President. Metrics required to be reported included the numbers of patent applications, patents received, and licenses executed, as well as the royalties received. Annual numbers of invention disclosures and CRADAs executed were subsequently added as metrics.

The clear purpose of these metrics was to enable the U.S. government to evaluate the T2 performance of its hundreds of research labs: How effective were they in generating new inventions and transferring them to the private sector for conversion into new products to benefit the national economy, create jobs, and advance economic competitiveness? Because these federal labs' T2 activities were new, it was recognized that it would be several years before they could generate any significant economic outcomes and impacts. Meanwhile, the statistics on T2 outputs and royalties would serve as surrogate indicators of T2 effectiveness and impact (Swearingen and Slaper 2012).

By the early 2000s, however, there was growing discontent with traditional T2 metrics (Langford et al. 2006; Swearingen and Slaper 2012). It was recognized that these metrics were mere proxies or correlates for the generally desired end results: impact on the U.S. economy and/or agency mission. For example, the number of new DoD patents is significant only if the patented inventions are put to practical, beneficial use. Similarly, the number of new DoD license agreements with industry is meaningless unless the licensed technologies are commercialized and contributing to either the defense mission or national economy (Swearingen and Slaper 2012).

In fact, the Obama administration issued the 2011 Presidential Memorandum because of its discontent with the 30-year-old T2 metrics and belief that the United States was not receiving adequate social and economic returns from its federal R&D investments. This memo required all federal agencies to "improve and expand" the T2 metrics that they provided in their annual reports. It ignited a coordinated effort by all federal agencies to revise their T2 metrics (White House 2011). Unfortunately, the concrete results from that initiative did not advance very far beyond expanding on the traditional metrics, such as breaking down the patents granted by technology areas, and adding metrics for the numbers of licenses granted to small businesses and new startup companies resulting from federal laboratory T2 agreements (NIST 2013).

Relative to the current project, the most significant development from the agencies' response to the 2011 Presidential Memorandum was a new emphasis on T2 impact analysis. Agencies were required to report their annual number of T2 impact studies along with abstracts of selected impact studies that highlighted the success of their T2 activities (NIST 2013). In addition, agencies were urged to collaborate with each other to develop mechanisms to more effectively evaluate their T2 economic outcomes and impacts (NIST 2013). In compliance, in 2013, the director of the Defense Laboratory Office issued a memorandum requesting that TechLink update its 2012 economic impact study of DoD license agreements (active since 2000) in 2015 and every subsequent three years.

The 2018 "Return on Investment (ROI) Initiative for Unleashing American Innovation" represented another major effort by the U.S. government to improve federal agency T2 performance and metrics. Specifically, this initiative was designed to advance the Lab-to-Market cross agency priority (CAP) goal of the Trump administration's President's Management Agenda. In many ways, this ROI Initiative was a continuation of the initiative launched by the Obama administration's 2011 Presidential Memorandum.

> The 2018 Return on Investment (ROI) Initiative represented another major effort to improve federal agency T2… Echoing the 2011 Presidential Memorandum, its intent was to "maximize the transfer of Federal investments in science and technology into value for America."

Echoing the 2011 Presidential Memorandum, the ROI Initiative's intent was to "maximize the transfer of Federal investments in science and technology into value for America" to (1) help meet current and future technological, economic, and national security needs; (2) enhance U.S. global competitiveness; and (3) attract greater private-sector investment to create innovative products as well as new businesses and

industries (NIST 2019). NIST, which serves as the coordinating entity for federal agency T2 across the U.S. government, was charged with leading the ROI Initiative for its parent agency, the Department of Commerce.

To implement the ROI Initiative, NIST solicited input nationwide through a Request for Information (RFI) in the Federal Register, held an extensive series of public meetings and engagement sessions with academic and private-sector stakeholders, hosted a summit that included policymakers, industry leaders, technology managers, and extensively consulted with interagency T2 working groups. It also published a Green Paper in 2019 that integrated the findings from its broad outreach with results from an extensive review of prior studies related to federal T2 policies and practices (NIST 2019). The IDA Science and Technology Policy Institute assisted NIST by summarizing the feedback and recommendations from the RFI and various forums, conducting the literature review, and integrating all the results for the Green Paper (Peña and Mandelbaum 2020).

T2 metrics figured large in the ROI Initiative's findings. One of these findings was that T2 outcomes and impacts from federal laboratories would continue to be lackluster "until laboratory leaders are directed, funded, and incentivized to place greater emphasis on commercialization outcomes, including through accountability to meaningful metrics" (NIST 2018, p. 80). Another key finding was that current federal T2 metrics "do not accurately reflect the impact or effectiveness of technology transfer because they measure technology transfer outputs and outcomes, not broad-based impacts resulting from technology transfer program activities (NIST 2019, p. 114).

The Green Paper discussed the critical need for new, more meaningful and effective T2 metrics, including metrics for T2 processes, outcomes, and impacts. While NIST did not recommend specific metrics, it clearly described the kind needed: *operational metrics* to assess and improve the efficiency of the T2 process and accelerate T2 processes; *R&D outcome metrics* beyond the traditional outcome metrics (invention disclosures, patent applications, issued patents, licenses, etc.) to help assess and improve R&D effectiveness, such as the ratio of patents filed to patents issued, the ratio of patents issued to patents licensed, and publications; and *R&D impact metrics*, such as new or improved products and services based on the intellectual property resulting from federal R&D, to assess the impacts of federally funded R&D on national security, economic competitiveness, job creation, commercial innovation, and other areas of broad societal benefit.

"However, despite the 2011 Presidential Memorandum and subsequent 2018 ROI Initiative, U.S. federal labs still use essentially the same metrics as they did in the 1980s to measure their T2 performance."

However, despite the 2011 Presidential Memorandum and subsequent 2018 ROI Initiative, U.S. federal labs still use essentially the same metrics as they did in the 1980s to measure their T2 performance. DoD still evaluates the success of its T2 efforts primarily by gathering annual tallies of invention disclosures, patent applications, patents issued, licenses and CRADAs executed, and royalties received.

Although these process metrics are important, they do not tell the most important part of the story: the longer-term outcomes and impacts resulting from technology transfer. The TechLink economic impact studies of DoD license agreements, and now of DoD CRADAs, demonstrated the general impact of the agency's T2 operations on the national economy (TechLink 2013, 2016, 2019b, 2019a, 2021, 2022). No other federal agency has a comparable mechanism to demonstrate its T2 impacts, although the Department of Energy (DOE) has started contracting with TechLink to conduct economic impact studies of several of its labs. TechLink's

studies for DoD also revealed sales to the U.S. military resulting from DoD's T2 agreements, which indicated that T2 is clearly benefiting the defense mission. TechLink's related success stories provided notable examples of DoD T2's impacts on both the defense mission and American public. However, DoD lacks regular mechanisms and metrics to track the outcomes and impacts of its license agreements and CRADAs, particularly on the defense mission. There is a critical need for the agency to develop additional metrics to improve the overall performance and mission-related effectiveness of its T2 system.

The 2021 IDA report, "Federal Technology Transfer Evaluation: An Overview of Measures and Metrics, Common Challenges, and Approaches to Improve Evidence-Building Capacity," discussed the multiple challenges faced by federal agencies in evaluating their T2 activities (Peña and Novak 2021). These challenges included (1) the shortcomings of using standardized T2 metrics, given different agency and lab missions and goals; (2) the fact that T2 outcomes and impacts occur at highly varying rates across technology fields and industries; (3) large variations in the type of R&D conducted at federal labs, which directly affects the quantity and commercial viability of the resulting inventions; (4) numerous difficulties in evaluating the economic impacts of T2 activities, particularly for an entire federal agency; (5) the long time horizon required for many T2 outcomes and impacts to be realized; and (6) the human tendency to focus on near-term process metrics (such as the numbers of invention disclosures, patent applications, etc.), even if those activities do not lead to significant outcomes or impacts.

To help address these challenges, the IDA team proposed that the U.S. government create an "a la carte" menu of metrics that can be selectively used across the federal lab system to evaluate T2. According to the IDA team, this could provide a more equitable narrative of T2 effectiveness, given the large differences between agencies and labs (Peña and Novak 2021). The IDA team also recommended that the government develop new metrics to enable comparative evaluations. One suggestion was normalization of existing quantitative metrics. For example, a federal agency or lab could create an index value to evaluate its T2 performance over time. It would do this by dividing each year's metric numbers (for example, the number of invention disclosures) by a benchmark value for that metric (e.g., the number of invention disclosures in 2015). These index metrics would enable T2 metrics in different labs to be more equitably compared. Another IDA team suggestion was adoption of new T2 metrics that link process and outputs to the desired outcomes. These metrics would augment existing quantitative metrics with qualitative approaches such as T2 case studies and success stories, to better capture T2 impacts on the national economy and the federal agency's mission.

Choudhry and Ponzio (2020), in their article, "Modernizing federal technology transfer metrics," discussed the continuing shortcomings of federal agency T2 metrics. To help address these shortcomings, they proposed two new metrics to assess T2 effectiveness: (1) the *filing ratio*, which is the ratio of the number of invention disclosures to the number of patent applications filed in a year; and (2) the *transfer rate*, which is obtained by dividing the annual number of new patent licenses by the annual number of patent applications. Choudhry and Ponzio claimed that the filing ratio is an effective measure of the prudent use of IP protection resources, and the transfer rate is an effective general measure of an agency or lab's T2 effectiveness. To demonstrate and evaluate the use of these proposed new metrics, they used patenting and licensing data from the Navy Medical Research and Development enterprise. Their results convincingly validated the utility of these two new metrics. Choudhry and Ponzio also suggested improved metrics for evaluating the effectiveness of CRADAs, including the number of DoD personnel involved, the number of joint peer-reviewed publications involving DoD and outside CRADA partners, and the number of patents resulting from CRADA projects. Other suggested new metrics included the length of elapsed time, from

start to finish, that it takes federal labs to establish CRADAs and license agreements as well as the time needed to find a licensee for a given invention.

Models

A significant number of the publications reviewed discussed T2 models relevant to the current project (e.g., Framst 1995; Bozeman 2000; Bozeman 2013; Peña and Mandelbaum 2020; Landree and Silberglitt 2018; Peña et al. 2021; Link et al. 2019, and Luna 2021). Most of these publications contained relevant insights and information.

The earliest known proposed use of logic models for T2 evaluation appeared in the 1995 article, "Application of program logic model to agricultural technology transfer programs" (Framst 1995). In this article, the author suggested that logic models provide an effective way to schematically present program objectives as well as the underlying cause-and-effect relationships between activities, outcomes, and impacts. Framst presented an experimental model that explicitly highlighted the desired ultimate societal benefits from a T2 program, and that included identification of outputs, performance indicators or metrics, and end goals. He illustrated the use of this model for evaluation of a hypothetical agricultural T2 program.

> The earliest publication proposing use of logic models to evaluate T2 appeared in 1995. It claimed that logic models provide an effective way to schematically present program objectives as well as the cause-and-effect relationships between activities, outcomes, and impacts.

Bozeman, in a comprehensive early review, examined the existing literature on T2, focusing primarily on "domestic technology transfer from universities and government laboratories" (Bozeman 2000, p. 627). To organize this literature, he created a "Contingent Effectiveness Model of Technology Transfer." Bozeman chose this name because his model assumed that parties involved in technology transfer have multiple objectives as well as multiple ways to assess whether T2 is effective. His model included five general elements that collectively determine T2 effectiveness: (1) the *transfer agent*, which is the entity seeking to transfer the technology; (2) the *transfer media* or T2 mechanism used; (3) the *transfer object* or what is being transferred; (4) the *transfer recipient* or organization receiving the transfer object; and (5) the *demand environment*—all the market and non-market factors establishing the context in which T2 is occurring (Bozeman 2000).

Following this extensive review, Bozeman found that there are six different criteria used by transfer agents to assess T2 effectiveness. The "out-the-door" criterion was (and still is) by far the most common and was assessed by metrics such as the annual number of license agreements. As measured by this criterion, once a license agreement is signed, the T2 objective is considered to have been successfully achieved. A second frequently used criterion was "market impact"—whether the transfer has resulted in a commercial outcome. This criterion typically used a surrogate indicator such as license royalties received. A third criterion was "economic development," which examined whether the transfer achieved an impact on the regional or national economy. According to Bozeman, this criterion was much discussed but rarely studied.

The three other effectiveness criteria, also rarely studied, included "political reward," such as increased funding for an organization because of its T2 success; "opportunity costs," such as whether the T2 benefited the transferring organization by helping it to achieve its mission; and "scientific and technical human capital,"

such as the impact of T2 on the STEM workforce (Bozeman 2000). Bozeman's model has now been widely used by other scholars to analyze and evaluate T2.

In the 2013 report that NIST commissioned in response to the 2011 Presidential Memorandum, Bozeman revisited the Contingent Effectiveness Model and revised it to include an additional effectiveness criterion: "public value" (Bozeman 2013). This criterion basically asks, "Did the technology transfer contribute to the society's well-being?" Bozeman also updated his earlier comprehensive review of the T2 literature. He again found that most studies, whether in university or federal lab settings, used the "out-the-door" measure to assess T2 effectiveness. He further noted that virtually all the federal agency responses to the 2011 Presidential Memorandum were based on out-the-door measures and metrics—the number of this or that T2 activity or output (Bozeman 2013). He commented that while these are important measures, they ignore downstream outcomes and impacts.

Bozeman specifically recommended that federal agencies make greater use of logic models to evaluate their T2 programs (Bozeman 2013). According to Bozeman, logic models enable program managers to effectively understand the *causal connections* between T2 inputs, activities, outputs, and impacts, so that they can better integrate the various interrelated elements. Most of these same observations were covered in Bozeman and colleagues' subsequent peer-reviewed article (Bozeman et al. 2015).

Link et al. (2019) in their lengthy analysis of T2 from federal agencies and labs, deployed a simple logic model to help conceptualize and standardize their analysis of T2 across the diverse federal agency landscape. More recently, Luna's short recent study, "Establishing an Evaluation Framework for Technology Transfer," applied the logic model framework to T2 at the U.S. Department of Transportation (Luna 2021).

In the IDA report titled "A Preliminary Concept for a Model of Federal Technology Transfer," Peña and Mandelbaum provided a comprehensive examination of the various models proposed for T2 evaluation, discussed their shortcomings, and proposed a new conceptual model (Peña and Mandelbaum 2020). This study was commissioned by NIST in 2018 as part of the ROI Initiative.

One of the major goals of this NIST-sponsored effort was to develop a general model for federal T2 operations able to (1) be applied across various agency missions and contexts; (2) fully capture T2 activities, inputs, outputs, and outcomes; (3) accurately portray the interrelationships between these key program elements; and (4) allow federal agencies to evaluate the performance of their T2 activities, devise appropriate metrics, recognize areas for improvement, and develop best practices (Peña and Mandelbaum 2020).

The IDA team reviewed previous T2 models and found that none were suitable for capturing the full range of federal agency T2 operations. Models reviewed included Bozeman's Contingent Effectiveness Model and Landree and Silberglitt's (2018) logic models of DoD T2, which are discussed further below. The IDA team's criticism of these existing models included that they (1) lacked a common definition of technology transfer; (2) did not adequately consider the diverse federal agency missions; and (3) did not adequately consider various internal and external factors that could be used to improve the T2 process (Peña and Mandelbaum 2020).

The IDA team proposed a new conceptual model for federal agency T2 to overcome the shortcomings of previous models. Unfortunately, this new model was too general and simplistic to be of practical use for DoD or any other federal agency. To help overcome this drawback, the IDA team developed three models having greater detail, each of which focused on one of the phases of T2: pre-transfer, transfer, and post-

transfer. These more detailed models enabled each of these phases to be visualized. However, again, they are of little practical use as a planning tool that a federal agency can use to improve its T2 operations. The greatest value of the 2020 IDA report lay in its discussion of the numerous complex internal and external factors that need to be considered in developing an effective T2 model.

A subsequent IDA report, "Opportunities to Advance Department of Defense Technology Transfer with Partnership Intermediary Agreements" (Peña et al. 2021) was commissioned by DoD to evaluate the agency's use of these partnership intermediary agreements (PIAs) for T2-related services. The project purpose was to analyze the landscape of organizations with which DoD had established PIAs (a total of 79 active agreements), examine the organizational and funding models of these partnership intermediaries and the specific activities they perform for DoD, and develop best practices for use of PIAs.

The primary relevance of this IDA report to the current project was its extensive use of a logic model to guide research. The IDA team effectively employed a logic model framework in several important ways: (1) to understand the relationships among resources, activities, outputs, and outcomes from DoD's use of PIAs; (2) to provide a concise way to visualize and communicate these relationships as well as the scope of activities pursued under PIAs; (3) to enable DoD to better understand how PIA activities could be channeled toward outputs and outcomes that would contribute to the defense mission; and (4) to identify metrics to measure PIA performance, which were categorized into metrics for activities, outputs, near-term outcomes, mid-term outcomes, and long-term impacts. This study was a valuable resource because of its insights into practical use of logic models.

The most valuable publication reviewed for this project was a RAND Corporation study titled "Application of Logic Models to Facilitate DoD Laboratory Technology Transfer."

By far the most helpful publication reviewed for this project was the RAND Corporation study titled "Application of Logic Models to Facilitate DoD Laboratory Technology Transfer" (Landree and Silberglitt 2018). As previously noted, an IDA team evaluated the RAND study's basic logic model and quickly dismissed it as not very applicable to non-DoD agencies (Peña and Mandelbaum 2020). However, contrary to that conclusion, we found this model highly relevant to all federal agencies and a particularly valuable resource for the current project.

The RAND study is highly relevant for three reasons. *First*, its basic premise was that, to be successful, DoD T2 needs to achieve outcomes that are in alignment with the DoD mission and generate products that support the Warfighter. *Second*, it clearly demonstrated how DoD can use logic models to monitor and track T2 from its R&D labs to end customers. *Third*, it provided guidance on how to develop metrics to monitor and evaluate T2 success.

The RAND authors first demonstrated how logic models are an effective framework for both envisioning the relationships among the inputs, activities, outputs, outcomes, and impacts of a generic T2 program as well as for evaluating the effectiveness of this program. Subsequently, they applied the logic model framework to DoD and constructed a basic model of what they considered a successful DoD T2 system.

In this model, DoD's R&D *activities* ideally lead to *outputs* (for example, new technologies) that are transferred to one or more *intermediate customers* (e.g., businesses) that, in turn, produce *intermediate outputs* (products) that could lead to *intermediate outcomes* (such as improvement of existing military technology) and/or direct use by DoD *end customers* (the U.S. military) to achieve *end outcomes* (e.g., improved Warfighter capabilities) that are in alignment with the laboratory or DoD mission.

The authors claimed that the logic model framework can be effectively used by DoD lab management to assess their T2 activities and determine which activities have been most effective at supporting the defense mission. As part of this effort, the logic model framework can help guide development of metrics to monitor the T2 system.

More broadly, the RAND authors posited that this methodology can be effectively used by the defense laboratory enterprise to monitor its R&D activities and evaluate the success of DoD labs in generating new technologies that are transitioned to DoD operational use. They claimed that one of its advantages is that it "can be applied across a broad set of organizations with differing missions and operations" (Landree and Silberglitt 2018, p. 6).

The TechLink research team was strongly influenced by this study's insights into how logic models can be effectively used to conceptualize T2 programs and evaluate their success. These insights helped guide the project team in developing the logic model of the current DoD T2 system as well of the proposed improved DoD T2 system.

Although the RAND study authors were adept in their discussion of logic models, they appeared to be relatively unfamiliar with T2 and the legislative mandates governing federal agency T2. For example, in their logic model, they ignored the legal obligation of all federal agencies to engage in T2 with the private sector to enhance U.S. competitiveness and leverage the nation's investment in federal R&D. Despite this, their study provided a valuable roadmap for developing logic models of the DoD T2 system.

Impacts

As previously noted, despite efforts to effect change, U.S. federal labs still use essentially the same metrics to measure their T2 performance as they did in the 1980s. These metrics primarily focus on activities and outputs, such as annual numbers of invention disclosures, patent applications, licenses executed, and royalties received. This reflects the prevailing "out-the door" mentality in which T2 practitioners consider their work complete when T2 agreements are executed and their IP is transferred to an outside party (Bozeman 2000). While metrics that tally activities and outputs are important, they ignore the most important purpose of the T2 process: the longer-term outcomes and impacts.

There have been relatively few studies of the economic impacts resulting from T2. Reasons include the usually long intervals between signing of T2 agreements and commercialization of new products and the perceived difficulty and cost of assessing long-term impacts.

There have been relatively few studies of the economic impacts resulting from technology transfer. Reasons include (1) the usually lengthy intervals between technology-transfer events and the commercialization of new products; (2) the perceived difficulty and significant costs of assessing long-term impacts; and (3) the conviction that, after technologies have been transferred to the private sector, subsequent commercialization activities and economic impacts are beyond the transferring institution's purview and control.

Link et. al (2019), in their voluminous report for NIST, "Overview and Analysis of Technology Transfer from Federal Agencies and Laboratories," attributed the lack of economic impact analysis to the lack of detailed

public domain data about federal T2 activities. To gain insight into the potential economic impacts, the Link team explored the economic impact of federal agency licenses on company sales, drawing on available data from a small number of EPA, NIH, and NIST T2 agreements. Their approach was to compare each licensing company's total sales *before* the license was executed to the company's *subsequent* sales. The sample size consisted of 458 licensees. Analysis drew on data from the NETS Database, which tracks the economic profiles of nearly 59 million firms. Using this approach, Link and his colleagues found that the percentage of licensees with an increase in inflation-adjusted sales after obtaining their license varied from 52% for NIST licensees to 74% for EPA licensees and 76% for NIH licensees. However, as the authors noted, they were unable to determine (1) when or if the licensing companies converted the licensed technologies into commercial products or (2) if the growth in company sales was even related to the license. Ultimately, the Link team was able to conclude only that licenses from federal labs were correlated with a positive effect on company sales. They described their research as a possible "starting point for more detailed studies of the sales impact of licensed federal technology" (Link et al. 2019, p. 8-12).

Although Link et al. cited TechLink's 2016 study of the economic impacts of DoD licenses in their literature review, they ignored this 2016 study in their chapter on the economic impacts from federal agency T2. The TechLink study demonstrated that far more is known about the economic impacts of federal agency T2 than the Link study indicated.

The 2016 TechLink economic impact study (EIS) surveyed all 602 companies with DoD license agreements active during the 2000-2014 period (TechLink 2016). The goal was to determine the contribution of these license agreements to new economic activity and job creation in the United States. The response rate was very high: 92% of the licensees participated in the survey, and the TechLink team was able to obtain full or partial information on 90% of the 733 total DoD license agreements, including total company sales and other revenues related to the licensed technology. Companies reported that 353 of the 733 license agreements (48%) had generated sales of products or services or other revenues (such as from sublicenses). The study broke these sales results down by company size, DoD technology source, technology sector, and whether sales were to the commercial or military sector. It also captured other economically important outcomes and impacts, such as the outside investment funding received by the licensees that was directly related to the licensed DoD technologies, the number of licensees that were acquired by larger corporations, the number of spin-out companies created, and the number of DoD technologies that were sublicensed to other companies.

> Since 2012, TechLink has been conducting comprehensive triennial economic impact studies of all DoD license agreements.

This 2016 EIS was part of an ongoing series, dating back to 2009, of TechLink studies of the economic impacts from DoD T2. In 2009, TechLink initiated a study of the national economic impacts of all TechLink-brokered T2 agreements for DoD (Swearingen and Slaper 2012). At roughly the same time, the Navy commissioned a similar EIS by the Indiana Business Research Center at Indiana University's Kelley School of Business in Bloomington, IN (Swearingen and Slaper 2012). Both studies surveyed companies with DoD T2 agreements to determine the sales resulting from these companies' agreements, then used the national IMPLAN model to estimate the total impacts on the national economy, including the economic multipliers—indirect and induced sales—and the associated jobs directly created or supported.

These two studies were followed by a 2012 TechLink EIS of all DoD license agreements then active since 2000 (TechLink 2013). The 2012 study became an integral part of DoD's official response to the 2011 Presidential Memorandum. At that time, the Director of the Defense Laboratory Office tasked TechLink with

conducting an update of the study in 2015. Since then, TechLink has updated the DoD licensing EIS every three years (TechLink 2016, 2019a, 2022).

In the initial 2009 study, TechLink developed the basic methodology that has been followed ever since. The TechLink team contacts all companies with the subject T2 agreements (licenses and, more recently, CRADAs) and asks these companies to divulge their total sales of new products and services resulting from these agreements. Companies are also asked about their related sales to the U.S. military, follow-on R&D contracts, revenue from sublicensing, sales by licensees and spin-out companies, and other economic outcomes. To encourage company disclosure of relevant sales, TechLink assures participants that only aggregated results will be reported, and that individual company sales figures will be kept entirely confidential. Next, economists at the collaborating university research centers—since 2015, the Business Research Division at the Leeds School of Business, University of Colorado Boulder—use IMPLAN economic impact assessment software to determine the economic multiplier effects of these sales and other revenue figures. The IMPLAN software estimates the total economic output, value added to the national gross domestic product (GDP), jobs created or supported (person-years of employment), labor income, and tax revenues directly attributable to the DoD T2 agreements.

In TechLink's latest 2022 DoD licensing EIS, the research team found that DoD license agreements active during the 2000-2021 period had resulted in $32.3 billion in total sales of new products and services (TechLink 2022). Of these, $5.05 billion consisted of sales to the U.S. military. The IMPLAN model estimated that, with economic multipliers, these T2-related sales had generated $69 billion in total nationwide economic output; $7 billion in new tax revenues at the federal, state, and local levels; and 246,783 cumulative jobs—or 11,751 per year—with average compensation of $84,643. In addition, these DoD license agreements had led to the creation of 205 new companies and the acquisition of 28 licensee companies by larger corporations.

In 2018, TechLink extended its economic impact research to DoD CRADAs (TechLink 2019b). That year, it initiated a pilot study of the national economic impacts from over 600 CRADAs established between 1996 and 2018 by three representative DoD labs—one each from the Army, Navy, and Air Force. These three labs were the U.S. Army Combat Capabilities Development Command Aviation & Missile Center, the Naval Surface Warfare Center Crane Division, and the Air Force Research Laboratory 711th Human Performance Wing. The primary purpose of this pilot project was to determine the feasibility of extending the TechLink EIS methodology to DoD CRADAs, which are approximately ten times more numerous than DoD license agreements and potentially more difficult to survey. That experiment proved successful. As a result, in 2021, TechLink initiated a multi-year EIS project to estimate the national economic impacts of all DoD CRADAs active since 2000, starting with Air Force CRADAs (TechLink 2021).

TechLink's economic impact studies of DoD T2 agreements were unique and groundbreaking. Prior to 2020, no other federal agency had undertaken a comparable study of its T2 outcomes and impacts.

These economic studies for DoD were unique and groundbreaking.
Prior to 2020, no other federal agency had undertaken a comparable study of its T2 outcomes and impacts. That changed when, in 2020, the DOE contracted with TechLink to conduct an EIS of Sandia National Laboratories' license agreements and CRADAs, followed by similar studies of Lawrence Livermore and Los Alamos national laboratories.

A few other researchers besides Link et al. (2019) and TechLink have attempted to estimate T2 economic impacts on a national scale. Roessner et al. (2013) attempted to estimate the contribution of university licensing to the U.S. economy using royalty income data from the nation's universities. Since 1991, the Association of University Technology Managers (AUTM), to which most U.S. universities belong, has been compiling annual statistics on university licensing in the United States. Statistics gathered include tallies of invention disclosures, patent applications, patents issued, licenses executed, and royalties received. The Roessner team drew directly on this publicly available data. Starting with the aggregated, cumulative royalty income received by U.S. universities over a 15-year period (1996-2010), and assuming a range of standard royalty rates, the Roessner team was able to estimate total university licensee sales. That is, they *divided* the royalty income by commonly used royalty rates to estimate total sales.

Assuming a 2% royalty rate, they estimated that university licensing generated at least $655 billion in gross output (sales). Assuming a 5% royalty rate, the estimated gross output was $262 billion. And it was $131 billion with a 10% rate. To these sales estimates, Roessner and his colleagues then applied coefficients (multiplier figures) from the U.S. Department of Commerce Bureau of Economic Analysis's national input-output (I-O) model. With these I-O coefficients, they were able to estimate the total value added to the national economy as well as the total number of jobs created. According to their estimates, the value added to the U.S. GDP over the 15-year period varied from a low of $52 billion (given a 10% royalty rate) to a high of $259 billion (with a 2% royalty rate). The number of jobs directly created or supported was estimated at 277,000 person years of employment.

Pressman et. al (2018) subsequently employed the Roessner team's methodology to estimate the national economic impacts from U.S. federal laboratory licensing. This effort was commissioned by NIST and was an important part of NIST's response to the previously discussed 2018 ROI Initiative. Like universities, U.S. federal agencies annually gather and report their total annual numbers of invention disclosures, patent applications, patents issued, licenses executed, and royalties received. These statistics are compiled and published annually by NIST. For the Pressman study, NIST provided licensing statistics for all reporting U.S. federal agencies for the years 2008-2015.

The Pressman team developed two different sets of estimates, which they referred to as Rev 1 and Rev 2. Rev 1 closely followed the procedures established by the Roessner team to estimate the economic impacts from university licensing in the U.S. However, the royalty rate assumptions were reduced to 1.4%, 2%, and 5%, which Pressman et al. assumed to be more typical of U.S. federal labs. Rev 2, a more refined and complex estimate, introduced several more realistic assumptions. One of these assumptions was that only 80% of the licensees' production occurred in the United States. This is important because foreign manufacturing of a product resulting from a federal lab license does not directly contribute to the U.S. economy. In this case, the Rev 1 model overestimates the economic impact of licensing on the U.S. economy, so Rev 2 totals are lower. However, other Rev 2 assumptions had an opposite effect and increased the total estimates.

The Pressman team's Rev 1 estimate of the gross output from federal laboratory licensing ranged from $76 billion using a 1.4% royalty rate to $54 billion with a 2% royalty rate and $23 billion with a 5% rate. The value added ranged from $35 billion to $11 billion. The Rev 2 estimates ranged from gross output of $84 billion using a 1.4% royalty rate to $59 billion with a 2% royalty rate and $25 billion with a 5% rate. The value added ranged from $41 billion to $13 billion.

The Pressman team noted that, although the annual total federal laboratory R&D expenditures were comparable to those of U.S. universities, the contributions to the U.S. economy from federal lab licensing

were *only roughly a tenth* the size of those from U.S. university licensing. They attributed this disparity in economic impact to several factors. These included the differences between universities and federal agencies in their respective missions, T2 policies, and regulatory frameworks. For example, R&D at DoD and DOE labs is tightly focused on the defense or national security mission and much of that research is either classified (and usually not subject to T2) or has limited commercial value. In addition, university licensing occurs under the Bayh-Dole framework, which gives universities more leeway in their license agreements than federal labs are provided under the Stevenson-Wydler framework. Finally, the Pressman team pointed out that federal labs generally do not collect royalties on sales to the U.S. government. As a result, these sales are not represented in the NIST royalty data, resulting in an underestimation of the economic impacts of federal lab T2.

Overall, the Pressman study represented a rigorous effort that yielded perhaps the best estimates of the impacts of federal agency T2 obtainable using the available NIST data. Their methodology, however, *substantially* underestimated the total contribution of federal lab licensing to the U.S. economy. For many federal agencies (including DoD, NIH, DOE, and NASA), a large percentage of the sales of products resulting from their T2 licenses are to the U.S. government. Being royalty free, they are consequently not captured in the NIST data. For DoD, for example, the 2016 TechLink licensing EIS showed that (excluding the sales from a single licensee involving a highly successful pharmaceutical product), sales to the U.S. military accounted for nearly 54% of the total sales (TechLink 2016).

While Pressman et al. did not provide economic impact estimates for the individual federal agencies included in their study, they did include a supplementary table on the licensing income for each individual agency. This table enabled construction of the DoD contribution to the totals reported for all agencies.

Using a 2% royalty rate, for example, the Pressman team estimated the DoD license-related gross output for the 2008-2015 period to be $5.5 billion. In comparison, the 2016 TechLink EIS discovered that total gross output from DoD license agreements for the 2000-2014 period was an estimated $48.8 billion. The inferred Pressman et al. estimate of $5.5 billion was only 11% of the $48.8 billion estimated by the 2016 TechLink study, which was based on sales figures provided directly by the DoD licensees. Further, as the TechLink EIS report explained, the $48.8 billion figure understated the reality and was significantly smaller than the actual gross output (TechLink 2016). The shorter period covered by the NIST data explains some of the disparity, but this example shows the limitations of the Pressman team's methodology.

Conclusion

The Task 1 literature review identified approximately 50 publications that initially appeared to be directly relevant and potentially useful for this project. All were carefully read and evaluated. The net result was that fewer than two dozen publications on T2 were found to offer truly helpful information or insights. Among this group, two publications proved to be valuable resources: the IDA report that used a logic model framework to analyze the DoD's use of partnership intermediary agreements for T2-related services (Peña et al. 2021); and the RAND Corporation report that demonstrated how logic models can be effectively used to conceptualize DoD laboratory T2 programs and evaluate their success (Landree and Silberglitt 2018). Together, these two publications illustrated effective use of logic models for evaluating T2. Both helped guide this project's development of logic models of the DoD T2 system.

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Appendix 5. Survey Questions

Initial Questionnaire: T2 Managers

1 Does your lab have established and documented tech-transfer processes--for example that cover roles and responsibilities, evaluation of inventions, review of agreements, ongoing management of patents and agreements, etc.? Please explain. **(Yes/No)**

2 Do you have the resources and support that you need to be successful in technology transfer? **(Yes/No)**

3 If not, which of the following is a problem? **(Ask to Explain if Yes)**

- Not enough personnel assigned to T2
- Insufficient training (if "Yes, this is a problem" ask what kind of training is needed)
- Budget is inadequate
- IP or legal support is inadequate or ineffective
- Lack of knowledge of new inventions in the lab
- Lack of cooperation from lab S&Es
- Lack of support from lab leadership
- Something else

4 How would you recommend fixing the problem(s) that you just identified?

5 How do you define success in technology transfer?

6 If you had enough resources and support, could your lab be significantly more successful with technology transfer? **(Yes/No)**

7 What metrics do you currently use to measure your lab's technology transfer success?

8 Do you think these metrics could be improved? If so, how? **(Yes/No)**

9 Do you consistently provide training to S&Es in IP protection and technology transfer? Please elaborate. **(Yes/No)**

10 Do you regularly interact with your lab's S&Es to learn of new technologies they are developing? If so, how? **(Yes/No)**

11 How do you market your lab's licensing and partnering opportunities to industry in order to develop T2 agreements?

12 What do you see as the main purpose or value of technology transfer for DoD?

13 Do you think DoD tech transfer is effective in supporting the defense mission? **(Yes/No)**

14 How could tech transfer be changed to better support the defense mission?

15 Could metrics be established to measure T2's impacts on the defense mission? What would be some examples of these metrics? **(Yes/No)**

16 What's an example of an outstanding tech-transfer success story at your lab?

17 Who else would you suggest that I interview? Would you please suggest some ORTAs, legal counsel, S&Es, and/or others?

18 May I contact you again if I have a few follow-up questions? **(Yes/No)**

Initial Questionnaire: Lab IP Counsel

1 Do you have other responsibilities outside of protecting the lab's intellectual property (for example, reviewing license agreements, CRADAs, and other contracts)? **(Yes/No)**

2 Do you feel you have the resources and support that you need to adequately protect DoD's inventions and other intellectual property? **(Yes/No)**

3 If not, which of the following is a problem? **(Ask to Explain if Yes)**

- Not enough personnel assigned to your office
- Too many other responsibilities
- Budget is inadequate
- Poor support from the T2 office
- Lack of support from lab leadership
- Lack of knowledge of new inventions in lab
- Lack of cooperation from lab S&Es
- Something else

4 How would you recommend fixing the problem(s) that you just identified?

5 Does your lab have an invention evaluation board or committee? If so, what stakeholder groups are represented and who makes the final decision on which disclosures are selected for the patent application process? **(Yes/No)**

6 Do you believe that your lab's S&Es are disclosing most of their inventions for your office to evaluate for patent protection? **(Yes/No)**

7 Do you consistently provide training to your lab's S&Es in IP protection and assist them with invention disclosures? Please explain. (**Yes/No)**

8 What metrics do you currently use to measure your office's success in protecting DoD inventions and intellectual property?

9 Do you think these IP protection metrics could be improved? If so, how? **(Yes/No)**

10 What do you see as the main purpose or value of protecting DoD inventions and other IP?

11 Do you think that protecting and transferring DoD inventions to industry is an effective way to support the defense mission? **(Yes/No)**

12 How could DoD IP protection and technology transfer be changed to better support the defense mission?

13 Could metrics be established to measure the impact of IP protection on the defense mission? **(Yes/No)**

14 What would be some examples of those metrics?

15 Who else in the legal or S&E community would you suggest that I talk to for a useful perspective on these matters?

16 May I contact you again if I have a few follow-up questions?

Initial Questionnaire: Lab S&Es

1 Is it important for your lab to patent its inventions and transfer those inventions to the private sector? If so, why? **(Yes/No)**

2 Do you interact with the T2 or legal office to make them aware of the new technologies that you are developing? **(Yes/No)**

3 Do you think it is important for you to disclose your inventions to the T2 or legal office? **(Yes/No)**

4 When preparing a technical article for publication, do you consider whether the article may contain patentable subject matter? **(Yes/No)**

5 Are you incentivized by your lab for submitting invention disclosures and/or being awarded patents? **(Yes/No)**

6 Have you encountered any problems in participating in the invention protection and/or technology transfer process? **(Yes/No)**

7 If so, what is the nature of the problem? **(Ask to Explain if Yes)**

- Not enough time to write invention disclosures or interact with industry
- Lack of understanding of the process
- The T2 office doesn't provide the necessary support
- The legal office doesn't provide the necessary support
- There isn't a budget to charge time to for this activity
- The branch or division chiefs don't think this is important
- These activities are not important for career advancement
- Something else

8 How would you recommend fixing the problem(s) that you just identified?

9 Is cooperative research with industry and universities (using CRADAs) important to your lab? If so, how or why? **(Yes/No)**

10 Is your participation in technology transfer activities considered important by your lab's senior leaders? **(Yes/No)**

11 What would be required for you to participate more actively in IP protection and technology transfer with industry?

12 Do you think that CRADAs and license agreements with industry are an effective way to support the defense mission? **(Yes/No)**

13 Could your lab's R&D goals and metrics be improved to better support the defense mission? **(Yes/No)**

14 What would you suggest to improve your lab's R&D goals and metrics in order to have a bigger impact on the defense mission?

15 How could your lab's tech-transfer activities (including both CRADAs and license agreements) be improved to better support the defense mission?

16 Who else in the S&E community would you suggest that I talk to for a helpful perspective on these matters?

17 May I contact you again if I have a few follow-up questions? **(Yes/No)**

Initial Questionnaire: Lab Leadership

1 Is it important for DoD to patent its inventions and transfer those inventions to the private sector? **(Yes/No)**

2 What do you see as the main purpose of protecting lab inventions and transferring them to industry?

3 Do you think that your S&Es are doing an adequate job of disclosing their inventions? **(Yes/No)**

4 If not, how would you suggest motivating S&Es to do a better job of disclosing their inventions?

5 Do you view transferring your lab's inventions to industry as a legal obligation or a DoD requirement? **(Yes/No)**

6 Are CRADAs with industry and universities important at your lab? If so, how or why are they important? **(Yes/No)**

7 Are CRADAs an important way to develop new technology for the U.S. warfighter? **(Yes/No)**

8 What could DoD do to entice industry to collaborate more fully with DoD labs on developing new technology for the warfighter?

9 Are you incentivized in your performance reviews to try to transition your lab's new technologies to the warfighter? **(Yes/No)**

10 Do you ever interact with acquisition programs to make them aware of new technologies your lab has developed? If so, how? **(Yes/No)**

11 How important is technology transfer in transitioning your lab's inventions into acquisition programs?

12 What are some examples of technologies that your lab has transitioned to DoD operational use?

13 Have you encountered any of the following problems in getting your lab's new technologies into acquisition programs? **(Ask to Explain if Yes)**

- Lack of a clearly defined process
- The acquisition community does not seem receptive
- The FAR seems to discourage transition from DoD labs
- The technology transfer process is too slow or ineffective
- Something else

14 How would you recommend fixing the problem(s) that you just identified?

15 Do you think that CRADAs and license agreements with industry are an effective way to support the defense mission? **(Yes/No)**

16 Could your lab's R&D goals and metrics be improved to better support the defense mission? **(Yes/No)**

17 What could DoD do to enable DoD labs to have a bigger impact on the defense mission?

18 How could DoD make technology transfer more effective at supporting the defense mission?

19 Who else in lab leadership would you suggest that I talk to for a helpful perspective on these matters?

20 May I contact you again if I have a few follow-up questions? **(Yes/No)**

Initial Questionnaire: Acquisition Community

1 How important is the DoD laboratory system in generating new technologies for acquisition programs and warfighter use?

2 Are you aware of any technologies that were developed in DoD labs and then transitioned into DoD acquisition programs? **(Yes/No)**

3 What are some examples of DoD-developed technologies that were transitioned to acquisition programs?

4 Does technology transfer, whether through license agreements or CRADAs, play an important role in transitioning DoD lab inventions to DoD operational use? **(Yes/No)**

5 Could the role of technology transfer in supporting the defense mission be increased or improved? If so, how? **(Yes/No)**

6 Do you ever interact with DoD labs to become aware of the new technologies they are developing? If so, how? **(Yes/No)**

7 Have you encountered any of the following problems in getting new DoD lab technologies into acquisition programs? **(Ask to Explain if Yes)**

- Lack of a clearly defined process
- The labs do not seem to be interested or receptive
- The FAR seems to discourage technology transition from DoD labs
- The technology transfer process is too slow or ineffective
- Something else

8 How would you recommend fixing the problem(s) that you just identified?

9 Are you incentivized in your performance reviews to transition DoD lab inventions into acquisition programs? **(Yes/No)**

10 Could DoD's R&D goals and metrics be improved to better support the defense mission? If so, how? **(Yes/No)**

11 Could DoD's acquisition programs be improved to better support the transition of DoD lab-developed technology? If so, how? **(Yes/No)**

12 Who else in the acquisition community would you suggest that I talk to for a helpful perspective on these matters?

13 May I contact you again if I have a few follow-up questions? **(Yes/No)**

Initial Questionnaire: Private Sector

1 How did you learn about the opportunity to engage with the Dept. of Defense through a T2 agreement (license or CRADA)?

2 Was establishing the agreement a smooth and timely process? **(Yes/No)**

3 If not, which of the following was a problem? **(Ask to Explain If Yes)**

- It was difficult to figure out the process
- The process seemed too bureaucratic
- It took too long to establish the agreement. (Do you recall how many months it took?)
- The terms were not favorable to your company
- The lab's T2 personnel were not very helpful
- The lab's lawyers were difficult to work with
- Something else

4 How would you recommend that DoD fix the problem(s) you just identified?

5 If you had a license agreement, what was the main value to your company of licensing government-developed technology? **(Check if N/A_____)**

6 Were there any downsides to licensing from the government? If so, please explain. **(Yes/No)**

7 If you had a CRADA, what were the advantages of collaborating with a DoD lab under that mechanism? **(Check if N/A_____)**

8 Were there any downsides to collaborating with DoD under a CRADA? If so, please explain. **(Yes/No)**

9 Have you had more than one CRADA or license agreement with DoD? **(Yes/No)**

10 Would you be willing to enter into future CRADAs or license agreements with DoD? **(Yes/No)**

11 If not, why not?

12 May I contact you again if I have a few follow-up questions? **(Yes/No)**

13 Size of Company

_____ **Large** (500+ employees)
_____ **Medium-Sized** (100-499 employees)
_____ **Small** (10-99 employees)
_____ **Very Small** (1-9 employees)

Appendix 6.
Complete Coded Interview Results

DoD T2 Managers

Coded Interview Responses

Question 1: ***Does your lab have established and documented tech-transfer processes—for example that cover roles and responsibilities, evaluation of inventions, review of agreements, ongoing management of patents and agreements, etc.? Please explain.***

Answer	#	%
Yes	58	94%
No	4	6%
Total	62	100%

The 59 qualitative answers to this question were coded into four unique thematic responses:

Code	Count	Frequency
Fully developed procedures and processes	24	41%
Only limited T2 procedures	21	36%
Partially developed, further development needed or underway	11	19%
No, but are currently developing them	3	5%

Total does not equal 100% because of rounding.

Question 2: ***Do you have the resources and support that you need to be successful in technology transfer?***

Answer	#	%
No	54	87%
Yes	8	13%
Total	62	100%

Question 3: ***If not, which of the following is a problem?***

3.1 Not enough personnel assigned to T2

Answer	#	%
Yes	38	61%
No	24	39%
Total	62	100%

3.2 Budget is inadequate

Answer	#	%
Yes	34	55%
No	28	45%
Total	62	100%

3.3 Insufficient training

Answer	#	%
Yes	33	53%
No	29	47%
Total	62	100%

3.4 Lack of reporting of new inventions in the lab

Answer	#	%
No	36	58%
Yes	26	42%
Total	62	100%

3.5 IP or legal support is inadequate or ineffective

Answer	#	%
No	37	60%
Yes	25	40%
Total	62	100%

3.6 Lack of cooperation from lab S&Es

Answer	#	%
No	43	69%
Yes	19	31%
Total	62	100%

3.7 Lack of support from lab leadership

Answer	#	%
No	43	69%
Yes	19	31%
Total	62	100%

3.8 Something else

Answer	#	%
No	51	82%
Yes	11	18%
Total	62	100%

The qualitative "Yes" answers in the "Something else" category were either too lab-specific or too incomplete to be coded into useful thematic categories.

Question 4: ***How would you recommend fixing the problem(s) just identified?***

The answers to this question were coded into 23 unique thematic responses:

Code	Count	Frequency
Provide more staff for T2 function, including more legal staff for IP protection and review of T2 agreements	21	34%
Provide more T2 education and training for S&Es and lab leadership on how T2 serves and benefits the defense mission, and include T2 as a measure of performance on their annual reviews	21	34%
Provide more baseline funding for T2 function	17	27%
Increase and improve T2 training for ORTAs	14	23%
There are currently no real problems	3	5%
Give greater priority to IP protection	2	3%
Give greater priority to CRADAs over license agreements	2	3%
Have T2 Professional recognized as a specific job category with specific career path	2	3%
Implement efficient IP database system for easy access by S&Es, legal staff, and T2 personnel	2	3%
Have dedicated Service or Component lead exclusively for T2	1	2%
Have IP counsel and licensing managers specialized in specific technology areas	1	2%
Increase and improve marketing of T2 opportunities to industry	1	2%
Integrate T2 more fully into the DoD acquisition process	1	2%
Provide economic incentives for invention disclosures and patents	1	2%
Standardize T2 processes across the DoD lab system	1	2%
Streamline license agreement and CRADA templates	1	2%
Change IP protection process to include more provisional patent applications to allow greater time for patenting decisions	1	2%
Combine Partnerships and T2 offices so there are better aligned with each other	1	2%
Increase interactions between T2 staff and S&Es	1	2%
Provide better definition of the difference between technology transfer and technology transition	1	2%
Provide gap funding to help jumpstart commercialization	1	2%
Obtain greater input from ORTAs on new T2 legislation	1	2%
Use outside parties to evaluate invention disclosures	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 5: ***How do you define success in technology transfer?***

The answers to this question were coded into 15 unique thematic responses:

Code	Count	Frequency
Delivering impactful new technology to the U.S. Warfighter	32	52%
Achieving mutual success for both DoD and its private-sector partners	19	31%
Getting DoD lab inventions out the door and commercialized in a timely way	18	29%
Achieving relatively high numbers of T2 agreements and other traditional metrics	9	15%
Benefiting the U.S. economy and providing a better ROI to the U.S. taxpayer from federal R&D dollars	5	8%
Effectively supporting the lab's S&Es	5	8%
Achieving a culture within DoD that highly values T2 and understands how it supports the defense mission	4	7%
Generating success stories of how DoD T2 benefits the American public	4	7%
Invigorating the S&E workforce by exposing it to private sector ideas and ingenuity	2	3%
Transitioning technology from the lab to DoD acquisition	2	3%
Using EPAs to cultivate the lab workforce	1	2%
Attracting repeat T2 partners	1	2%
Benefiting the U.S. economy and providing a better ROI to U.S. taxpayer from federal R&D dollars	1	2%
Executing T2 agreements in a timely way	1	2%
Helping to create new startup companies	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 6: ***If you had enough resources and support, could your lab be significantly more successful with technology transfer?***

Answer	#	%
Yes	49	79%
No	10	16%
Not Sure	3	5%
Total	62	100%

Question 7: ***What metrics do you currently use to measure your lab's T2 success?***

The answers to this question were coded into 16 unique thematic responses:

Code	Count	Frequency
Just the metrics we're required to report annually	29	47%
Examples of T2 successes and impacts, in addition to the required annual metrics	8	13%
Income from T2 agreements, in addition to the required annual metrics	6	10%
Increases in numbers of T2 metrics, in addition to the required annual metrics	6	10%
Impact on the defense mission, in addition to the required annual metrics	4	6%
Time to complete T2 agreements, in addition to the required annual metrics	3	5%
The number of lab technologies fielded, in addition to the metrics we're required to report annually	2	3%
The number of non-federal partners, in addition to the required annual metrics	2	3%
Engagement of local businesses in T2 with the lab, in addition to the required annual metrics	1	2%
Estimated value of partner contributions to T2 agreements, in addition to the required annual metrics	1	2%
Grant proposal submissions and letters of intent, in addition to the required annual metrics	1	2%
Improvements in DoD lab technologies, in addition to the required annual metrics	1	2%
S&E satisfaction with T2 support, in addition to the required annual metrics	1	2%
Workforce recruitment from EPAs, in addition to the required annual metrics	1	2%
Number of small business partners, in addition to the required annual metrics	1	2%
Numbers of unique partners, unique S&Es engaged in T2, and proximity of partners to the lab, increases in numbers of T2 metrics, in addition to the required annual metrics	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 8: ***Do you think these metrics could be improved? If so, how?***

Answer	#	%
Yes	47	76%
No	8	13%
Not Sure	7	11%
Total	62	100%

The qualitative "Yes" answers to this question were coded into 21 unique thematic responses:

Code	Count	Frequency
By assessing the quality of T2 outcomes as opposed to measuring T2 activities	11	18%
By measuring T2's impact on the defense mission	8	13%
By measuring the downstream outcomes and impacts from T2	8	13%
Yes, but not sure how	8	13%
By standardizing T2 metrics across the DoD enterprise	5	8%
Current T2 metrics are adequate	5	8%
By measuring the time it takes to execute T2 agreements	3	5%
By measuring improvements to DoD lab technologies that result from T2 agreements	3	5%
By measuring increases in numbers of T2 agreements over time	2	3%
By measuring intangibles from T2 such as S&E workforce knowledge advancement and satisfaction	2	3%
By tracking cost savings to DoD from T2 agreements	2	3%
By adding meaningful metrics that measure outcomes within the ORTA's control	2	3%
By emphasizing and measuring the use of other T2 mechanisms besides license agreements and CRADAs	1	2%
By measuring the number of S&Es trained each year in IP protection and T2	1	2%
By tracking the number of patents coming out of T2 agreements such as licenses and CRADAs	1	2%
Through measuring the number of unique S&Es engaging in the lab's T2 process over time	1	2%
By adding qualitative metrics, such as stories of successful T2 outcomes and impacts	1	2%
By adding the number of collaborations with other agencies	1	2%
By measuring the ROI on the resources required for the T2 agreement	1	2%
By training acquisition personnel on how T2 can be used to support the defense mission	1	2%
By making it easier for S&Es to engage in T2	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 9: ***Do you consistently provide training to S&Es in IP protection and technology transfer? Please elaborate.***

Answer	#	%
No	34	55%
Yes	28	45%
Total	62	100%

The qualitative answers to this question were coded into 10 unique thematic responses:

Code	Count	Frequency
No, however, we occasionally provide T2 training on an *ad hoc* basis	20	33%
We provide both regularly scheduled training as well as *ad hoc* training as needed or requested	11	18%
We provide regularly scheduled training in IP protection and T2	10	16%
We provide one-on-one *ad hoc* training as needed or required	6	10%
No, we do not provide T2 training to S&Es	5	8%
In addition to formal training, we also give "lunch and learn" presentations on IP protection and T2	4	7%
No, but we are currently developing a training program	3	5%
No, we do not provide IP protection and T2 training to S&Es	3	5%
No, however, we do provide one-on-one training to new S&Es	1	2%
We provide mandatory training in IP protection and T2 to all new S&Es, in addition to providing regularly scheduled training to the lab's S&Es	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 10: ***Do you regularly interact with your lab's S&Es to learn of new technologies they are developing? If so, how?***

Answer	#	%
Yes	39	63%
No	15	24%
N/A	8	13%
Total	62	100%

The answers to this question were coded into 13 unique thematic responses:

Code	Count	Frequency
Interact mainly when S&Es contact the ORTA for advice or notification of new inventions	26	43%
Learn of new S&E-developed technologies through attending meetings of lab management staff	12	20%
Regularly interact with lab's known inventors and conduct one-on-one meetings with other S&Es believed to be developing innovations	9	15%
N/A because lab doesn't develop any new technology	8	13%
Learn of new technologies through attending lab's periodic technology reviews	5	8%
Learn of new technologies when leading tours of lab facilities	5	8%
Learn of new inventions through participating in the lab's Invention Evaluation Board	4	7%
Learn of new technologies through helping S&Es with CRADAs	3	5%
Learn of new lab technologies through attending S&E briefings to industry	3	5%
Interact with S&Es and learn of new technologies through attending training sessions	2	3%
Reviews all lab technology reports to identify new technologies	2	3%
Learn of new lab-developed technologies through innovation discovery events	1	2%
Learn of new technologies through reviewing the public release forms	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 11: ***How do you market your lab's licensing and partnering opportunities to industry in order to develop T2 agreements?***

The answers to this question were coded into 14 unique thematic responses:

Code	Count	Frequency
Mainly through TechLink for licensing	26	43%
Briefings to industry and economic development organizations	17	28%
Through local PIA(s)	15	25%
Through S&Es	14	23%
Posting on lab website	11	18%
Rely on companies to contact us	11	18%
Trade shows or tech showcases	10	17%
Direct email marketing to companies	7	12%
Through TechLink and other PIAs	6	10%
Posting on lab and other public websites	6	10%
Posting on FLC website	4	7%
Social media marketing	4	7%
We don't do any marketing	4	7%
Through interactions with other DoD programs	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 12: ***What do you see as the main purpose or value of technology transfer for DoD?***

The answers to this question were coded into seven unique thematic responses:

Code	Count	Frequency
To support the U.S. defense mission by leveraging the ingenuity, resources, and capabilities of the private sector	53	85%
To strengthen the nation's economy and defense mission	17	27%
To increase the ROI to the U.S. taxpayer	12	19%
To leverage the capabilities of university researchers	5	8%
To increase the lab's visibility outside the fence in order to generate political support	2	3%
To protect DoD's intellectual property	1	2%
To prevent base closure (“BRAC”)	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 13: ***Do you think DoD T2 is effective in supporting the defense mission?***

Answer	#	%
Yes	49	79%
No	10	16%
Not sure	3	5%
Total	62	100%

Question 14: ***How could T2 be changed to better support the defense mission?***

The answers to this question were coded into 20 unique thematic responses:

Code	Count	Frequency
Through educating lab leaders on how T2 supports the defense mission and motivating them to support T2 by including T2 metrics in their performance evaluations	13	21%
By streamlining, standardizing, and accelerating DoD T2 processes	12	19%
By strengthening the links between T2 and DoD acquisition and end users	10	16%
Through changes in DoD policy and instructions	10	16%
By providing an adequate budget for the T2 function	9	15%
By focusing more on spin-in of private-sector technology to address critical DoD technology needs	5	8%
Not sure	5	8%
Through mandatory T2 training for all lab personnel	5	8%
By establishing a "technology pull" system that starts with DoD requirements	4	6%
Through better outreach to non-traditional companies emphasizing the benefits of T2	4	6%
Through T2 training customized for DoD, emphasizing how T2 tools can be effectively used to support the defense mission	3	5%
Through greater emphasis on T2 in performance reviews for S&Es	2	3%
Through improving ways to find strong T2 partners, such as through the use of artificial intelligence	2	3%
By encouraging T2 involving dual-use technologies	1	2%
By requiring T2 training for lab leadership so they understand how T2 supports the defense mission	1	2%
It doesn't need to be changed	1	2%
Through emphasizing success stories in how T2 supports the defense mission	1	2%
Through greater emphasis on licensing to industry	1	2%
Through better guidance on how T2 activities can be funded	1	2%
By adding T2 metrics related to transition	1	2%

Total does not equal 100% because each complete answer may include multiple themes.

Question 15: ***Could metrics be established to measure T2's impacts on the defense mission? What would be some examples of these metrics?***

Answer	#	%
Yes	51	82%
Not sure	7	11%
No	2	3%
No response	2	3%
Total	62	99%

Total does not equal 100% because of rounding.

The "Yes" answers to this question were coded into five unique thematic responses:

Code	Count	Frequency
Transition to DoD operational use	24	47%
Not sure	20	39%
Increases in Warfighter capabilities	14	27%
Success stories of impacts on the defense mission	11	22%
Cost savings and cost avoidance	5	10%

Total does not equal 100% because each complete answer may include multiple themes.

DoD Scientists and Engineers (S&Es)

Coded Interview Responses

Question 1*: Is it important for your lab to patent its inventions and transfer those inventions to the private sector? If so, why?*

Answer	#	%
Yes	17	94%
No	1	6%
Total	18	100%

The "Yes" answers to this question were coded into nine unique thematic responses:

Code	Count	Frequency
To protect DoD's intellectual property	7	41%
So the private sector can develop military products to support the defense mission	5	29%
To benefit the U.S. economy and American public	4	24%
It provides career-enhancing recognition for the lab's inventors	3	18%
No explanation	2	12%
It can generate revenues for inventors from royalty income	2	12%
Patenting is important so DoD doesn't have to pay twice for the same technology	2	12%
To enhance the reputation of the lab as a center of excellence	2	12%
Patenting is necessary to motivate industry to commercialize a lab's technology for military and civilian use	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 2: ***Do you interact with the T2 or legal office to make them aware of the new technologies that you are developing?***

Answer	#	%
Yes	17	94%
No	1	6%
Total	18	100%

The "Yes" answers to this question were coded into three unique thematic responses:

Code	Count	Frequency
Regularly	11	65%
Only when I think it's necessary	4	24%
No explanation	2	12%

Total does not equal 100% because of rounding.

Question 3: ***Do you think it is important for you to disclose your inventions to the T2 or legal office?***

Answer	#	%
Yes	16	89%
Not sure	2	11%
Total	18	100%

Question 4*: When preparing a technical article for publication, do you consider whether the article may contain patentable subject matter?*

Answer	#	%
Yes	14	78%
No	4	22%
Total	18	100%

Question 5: ***Are you incentivized by your lab for submitting invention disclosures and/or being awarded patents?***

Answer	#	%
Yes	15	83%
No	3	17%
Total	18	100%

The "Yes" answers to this question were coded into three unique thematic responses:

Code	Count	Frequency
Lab provides small monetary rewards	15	100%
Submitting invention disclosures and/or being awarded patents is recognized in performance evaluations	3	20%
Lab recognizes patenting with awards	3	20%

Total does not equal 100% because each complete answer may include multiple themes.

Question 6: ***Have you encountered any problems in participating in the invention protection and/or technology transfer process?***

Answer	#	%
Yes	14	78%
No	4	22%
Total	18	100%

Question 7: ***If so, what is the nature of the problem?***

7.1 Not enough time to write invention disclosures or interact with industry

Answer	#	%
No	10	56%
Yes	8	44%
Total	18	100%

7.2 Lack of understanding of the process

Answer	#	%
No	14	78%
Yes	4	22%
Total	18	100%

7.3 The T2 office doesn't provide the necessary support

Answer	#	%
No	17	94%
Yes	1	6%
Total	18	100%

7.4 The legal office doesn't provide the necessary support

Answer	#	%
No	11	61%
Yes	7	39%
Total	18	100%

7.5 There isn't a budget to charge time to for this activity

Answer	#	%
No	11	61%
Yes	7	39%
Total	18	100%

7.6 The branch or division chiefs don't think this is important

Answer	#	%
No	12	67%
Yes	6	33%
Total	18	100%

7.7 These activities are not important for career advancement

Answer	#	%
No	13	72%
Yes	5	28%
Total	18	100%

7.8 Something else

Answer	#	%
No	13	72%
Yes	5	28%
Total	18	100%

The qualitative "Yes" answers in the "Something else" category were either too lab-specific or too incomplete to be coded into useful thematic categories.

Question 8: ***How would you recommend fixing the problem(s) that you just identified?***

The answers to this question were coded into 14 unique thematic responses:

Code	Count	Frequency
Fully educate lab leaders on how IP protection and T2 support the defense mission and incentivize them to strongly support these activities	6	33%
No problems that need to be fixed	4	22%
Provide an overhead charge code to S&Es to enable them to charge time spent on IP protection and participation in the T2 process	3	17%
Provide adequate legal staff to support the IP protection and T2 function	3	17%
Provide a sustained adequate budget for the T2 function	3	17%
Incentivize S&Es to care about whether their technology transitions	2	11%
Train S&Es to better understand business issues and concerns so that DoD and industry can collaborate more effectively for mutual benefit	1	6%
Streamline and facilitate the invention disclosure process	1	6%
Provide better guidance to S&Es on lab's R&D goals	1	6%
Not sure	1	6%
Make participation in IP protection and T2 part of S&Es' performance reviews	1	6%
Lab management needs to stop micromanaging the T2 process	1	6%
DoD needs to find better ways to work around security issues to enable patenting of lab inventions	1	6%
Adequately staff the T2 office	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 9: ***Is cooperative research with industry and universities (using CRADAs) important to your lab? If so, how or why?***

Answer	#	%
Yes	18	100%
No	0	0%
Total	18	100%

The qualitative answers to this question were coded into nine unique thematic responses:

Code	Count	Frequency
It leverages the expertise, capabilities, and resources of industry and academia	15	83%
It leads to increased technology transition	3	17%
It makes DoD lab inventors more aware of the state-of-the-art in different technology fields	2	11%
It educates industry and academia about DoD mission needs	2	11%
It makes industry aware of DoD lab technologies available for licensing	1	6%
It leads to increased DoD patents	1	6%
It enables DoD to get its lab technologies across the "valley of death"	1	6%
CRADAs enable R&D projects with industry in an environment that protects each party's IP	1	6%
Collaboration with outside parties leads to new technology ideas	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 10: ***Is your participation in technology transfer activities considered important by your lab's senior leaders?***

Answer	#	%
Yes	13	72%
No	4	22%
It depends	1	6%
Total	18	100%

The qualitative answers to this question were coded into five unique thematic responses:

Code	Count	Frequency
They consider it to be important	5	28%
Somewhat, but it is low priority	5	28%
No, they don't support T2	4	22%
It is only considered important if it directly supports the defense mission	3	17%
This varies from leader to leader	1	6%

Total does not equal 100% because of rounding.

Question 11: ***What would be required for you to participate more actively in IP protection and technology transfer with industry?***

The answers to this question were coded into 10 unique thematic responses:

Code	Count	Frequency
S&Es need a dedicated budget line to charge these activities to	4	22%
Understanding and support from lab leadership	3	17%
Not sure	3	17%
More staffing for the S&E group	2	11%
Give S&Es the time and budget to attend more conferences and interact more with industry	2	11%
Better support from the legal and T2 offices	2	11%
Streamline, accelerate, and facilitate the IP protection and T2 processes	1	6%
Nothing is required	1	6%
Make T2 agreements more flexible	1	6%
Make IP protection and participation part of S&Es' performance reviews	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 12: ***Do you think that CRADAs and license agreements with industry are an effective way to support the defense mission?***

Answer	#	%
Yes	17	94%
No	1	6%
Total	18	100%

Question 13: ***Could your lab's R&D goals and metrics be improved to better support the defense mission?***

Answer	#	%
Yes	15	83%
No	3	17%
Total	18	100%

Question 14: ***What would you suggest to improve your lab's R&D goals and metrics to have a greater impact on the defense mission?***

The answers to this question were coded into 12 unique thematic responses:

Code	Count	Frequency
DoD's R&D efforts need more sustained support to ensure that promising inventions become fully developed and transitioned to the Warfighter	5	28%
Not sure	3	17%
Evaluate lab leadership on extent to which lab-developed technologies are supporting the defense mission	3	17%
Provide significant recognition for S&Es whose new technologies are supporting the defense mission	2	11%
No changes needed	2	11%
Measure whether lab-developed technologies transition to programs of record	2	11%
Establish stronger connections with the acquisition community so they are aware of the lab's new mission-relevant technologies	2	11%
Provide better education to S&Es on the importance of IP protection and T2 to the defense mission	1	6%
Promote greater R&D collaboration and integration with R&D efforts in other DoD components	1	6%
Establish a system to cross-reference S&T efforts across DoD to reduce duplication of efforts	1	6%
Encourage more risk taking in DoD's R&D programs	1	6%
Educate lab leadership on how T2 supports the defense mission	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 15: ***How could your lab's tech-transfer activities (including both CRADAs and license agreements) be improved to better support the defense mission?***

The answers to this question were coded into 11 unique thematic responses:

Code	Count	Frequency
Through adequately funding S&Es to participate in T2 and technology transition activities	4	22%
Through better T2 training for S&Es, both new and experienced	3	17%
They already effectively support the defense mission	3	17%
By adopting standardized and streamlined T2 templates across DoD	3	17%
The T2 office needs to become more proactive in finding outside T2 partners	2	11%
By making all lab employees, from top to bottom, more aware of T2 and what it can accomplish	2	11%
By incentivizing lab leadership to more strongly support T2	2	11%
Not sure	1	6%
By focusing more on the quality of T2 activities rather than the number of agreements	1	6%
By establishing metrics on the impact of DoD T2 on the national economy and defense mission	1	6%
By adequately funding and staffing the legal and T2 offices that support the T2 function	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Legal Counsel

Coded Interview Responses

Question 1: ***Do you have other responsibilities outside of protecting the lab's intellectual property (for example, reviewing license agreements, CRADAs, and other contracts)?***

Answer	#	%
Yes	17	94%
No	1	6%
Total	18	100%

Question 2: ***Do you feel you have the resources and support that you need to adequately protect DoD's inventions and other intellectual property?***

Answer	#	%
No	15	83%
Yes	2	11%
N/A	1	6%
Total	18	100%

Question 3: ***If not, which of the following is a problem?***

3.1 Not enough personnel assigned to your office

Answer	#	%
Yes	9	50%
No	8	44%
N/A	1	6%
Total	18	100%

3.2 Too many other responsibilities

Answer	#	%
No	13	72%
Yes	4	22%
N/A	1	6%
Total	18	100%

3.3 Budget is inadequate

Answer	#	%
Yes	10	56%
No	7	39%
N/A	1	6%
Total	18	101%

Total does not equal 100% because of rounding.

3.4 Poor support from the T2 office

Answer	#	%
No	11	61%
Yes	6	33%
N/A	1	6%
Total	18	100%

3.5 Lack of support from lab leadership

Answer	#	%
No	10	56%
Yes	6	33%
Not sure	1	6%
N/A	1	6%
Total	18	101%

Total does not equal 100% because of rounding.

3.6 Lack of knowledge of new inventions in lab

Answer	#	%
Yes	11	61%
No	6	33%
N/A	1	6%
Total	18	100%

3.7 Lack of cooperation from lab S&Es

Answer	#	%
No	11	61%
Yes	6	33%
N/A	1	6%
Total	18	100%

3.8 Something else

Answer	#	%
No	14	78%
Yes	3	17%
N/A	1	6%
Total	18	101%

Total does not equal 100% because of rounding.

The ”Yes” answers to Question 3.8 were coded into three thematic responses:

Code	Count	Frequency
The CRADA template needs to allow for greater flexibility rather than being standardized for the entire service	1	33%
The lab sometimes compromises the lab's IP through engaging in industry events and disclosing the IP before it is adequately protected	1	33%
The T2 process is too rigid and too averse to new ideas	1	33%

Question 4: ***How would you recommend fixing the problem(s) that you just identified?***

The answers to this question were coded into 16 unique thematic responses:

Code	Count	Frequency
Establish a larger, more stable budget for IP protection and legal support for T2	5	28%
Motivate DoD leadership to prioritize IP protection and T2 in support of the defense mission	3	17%
Establish better coordination on IP protection between different labs and programs	3	17%
Increase the number of legal personnel dedicated to IP protection and T2 support	3	17%
We don't have any major problems that need to be fixed	2	11%
Give the T2 office more personnel and authority	2	11%
Incentivize S&Es to engage in IP protection and T2 through including these activities in their performance review	2	11%
Establish a centralized IP management database	2	11%
Not sure	1	6%
Allow more remote work to help labs recruit and hire more legal staff	1	6%
Have the T2 office work with the lab's S&Es to help assess invention disclosures for patentability	1	6%
Experiment with creative approaches to increase IP protection	1	6%
No response	1	6%
Prioritize the quality of patent applications over the number of applications	1	6%
Increase the incentives offered to S&Es to encourage their participation in IP protection and T2	1	6%
Make greater use of local PIAs	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 5: ***Does your lab have an invention evaluation board or committee? If so, what stakeholder groups are represented and who makes the final decision on which disclosures are selected for the patent application process?***

Answer	#	%
Yes	8	44%
No	7	39%
Not sure	2	11%
N/A	1	6%
Total	18	100%

The qualitative "Yes" answers were either too lab-specific or too incomplete to be coded into useful thematic categories.

Question 6: ***Do you believe that your lab's S&Es are disclosing most of their inventions for your office to evaluate for patent protection?***

Answer	#	%
No	11	61%
Yes	3	17%
Not sure	3	17%
N/A	1	6%
+Total	18	101%

Total does not equal 100% because of rounding.

Question 7. ***Do you consistently provide training to your lab's S&Es in IP protection and assist them with invention disclosures? Please explain.***

Answer	#	%
Yes	11	61%
No	6	33%
N/A	1	6%
Total	18	100%

The qualitative answers to this question were coded into four unique thematic responses:

Code	Count	Frequency
Training is rarely done	6	33%
Provide training on a regular schedule	5	28%
Most training is on an ad hoc basis	5	28%
No explanation or no response	2	11%

Question 8: ***What metrics do you currently use to measure your office's success in protecting DoD inventions and intellectual property?***

The answers to this question were coded into 10 unique thematic responses:

Code	Count	Frequency
Number of patent applications	8	44%
Number of issued patents	8	44%
We have no specific metrics	6	33%
Number of invention disclosures	4	22%
Number of patent applications that result in issued patents	3	17%
How long it takes to complete different IP tasks	2	11%
Patent applications and issued patents compared to historic averages	1	6%
Number of cases allowed under secrecy orders	1	6%
Number of patent application amendments	1	6%
No response	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 9: ***Do you think these IP protection metrics could be improved? If so, how?***

Answer	#	%
Yes	12	67%
No	4	22%
Not sure	1	6%
N/A	1	6%
Total	18	101%

Total does not equal 100% because of rounding.

The "Yes" answers to this question were coded into 10 unique thematic responses:

Code	Count	Frequency
By measuring the percentage of patents that are licensed by industry	4	33%
Through prioritizing the quality of patents rather than the number of patents	3	25%
Through the use of an effective, user-friendly IP management system	2	17%
Through measuring the impact of DoD lab technologies on the defense mission or U.S. economy	2	17%
By measuring the ratio of the number of issued patents to the number of invention disclosures	2	17%
By examining how many patents stand up in court under patent infringement legislation	1	8%
Measuring the amount of R&D funds expended per invention disclosure	1	8%
By measuring whether the lab pays the 2nd and 3d patent maintenance fees	1	8%
By measuring the ratio of invention disclosures to the number of CRADAs	1	8%
By getting client feedback	1	8%

Total does not equal 100% because each complete answer may include multiple themes.

Question 10: ***What do you see as the main purpose or value of protecting DoD inventions and other IP?***

The answers to this question were coded into seven unique thematic responses:

Code	Count	Frequency
To prevent DoD contractors from claiming the invention and charging DoD for it	9	50%
It enables DoD lab inventions to be transferred to industry to support the U.S. Warfighter	8	44%
It enables DoD lab inventions to be transferred to industry to benefit the U.S. economy and American public	5	28%
To protect the U.S. government from patent infringement claims	4	22%
Patents are good evidence of lab productivity and value	3	17%
Patenting inventions provides recognition for lab S&Es	3	17%
To give the U.S. government the freedom to practice the invention	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 11: ***Do you think that protecting and transferring DoD inventions to industry is an effective way to support the defense mission?***

Answer	#	%
Yes	17	94%
No	1	6%
Total	18	100%

Question 12: ***How could DoD IP protection and technology transfer be changed to better support the defense mission?***

The answers to this question were coded into 15 unique thematic responses:

Code	Count	Frequency
Through better marketing of its inventions	3	17%
Not sure	3	17%
DoD needs to become more sophisticated and strategic in managing its patent portfolio and T2 efforts	2	11%
Through educating lab leadership on how IP protection and T2 supports the defense mission	2	11%
Through supporting the IP protection and T2 function with an adequate staff and budget	2	11%
By auditing the patented inventions resulting from DoD contracts and agreements	1	6%
By prioritizing patent quality over quantity, which would encourage more licensing of DoD lab inventions	1	6%
By standardizing and streamlining T2 processes and agreements across the DoD	1	6%
DoD needs a centralized database of its IP and inventions so S&Es can understand the R&D occurring in other DoD labs	1	6%
DoD T2 personnel need better training in business and legal issues	1	6%
Free DoD patent attorneys from lower-value administrative tasks, so they can focus on IP protection	1	6%
Make it easier to collaborate on R&D projects with universities, which should be treated differently than for-profit companies	1	6%
Patents and IP should be managed at the enterprise rather than individual lab level, they can be managed more strategically	1	6%
Though establishing a lower-cost patent filing fee and maintenance fee schedule for the U.S. government, which would enable DoD labs to patent more of their inventions	1	6%
Through promoting IP protection and T2 for dual-use lab technologies	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 13: ***Could metrics be established to measure the impact of IP protection on the defense mission?***

Answer	#	%
Yes	18	100%
No	0	0%
Total	18	100%

Question 14: ***What would be some examples of those metrics?***

The answers to this question were coded into nine unique thematic responses:

Code	Count	Frequency
Measuring the number of lab inventions that transition to DoD operational use	4	22%
Metrics on cost savings to DoD from T2	4	22%
Not sure	4	22%
Metrics on knowledge transfer, such as citations of S&E publications	2	11%
Measuring the impact of DoD lab inventions on the defense mission	2	11%
Measuring DoD's cost avoidance through patenting versus paying DoD contractors for use of DoD inventions and paying to protect DoD against patent infringement	2	11%
Measuring the number of licenses or CRADAs per patent	1	6%
Measuring the number of patented inventions resulting from DoD grants and contracts	1	6%
Success stories of the impact of DoD lab inventions on the defense mission and U.S. economy	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Lab Leadership

Coded Interview Responses

Question 1: ***Is it important for DoD to patent its inventions and transfer those inventions to the private sector?***

Answer	#	%
Yes	15	94%
No	1	6%
Total	16	100%

The qualitative answers to this question were coded into nine unique thematic responses:

Code	Count	Frequency
No explanation	6	38%
Yes, to protect the U.S. government's rights to the technology	5	31%
Yes, it acknowledges and rewards the DoD inventors	2	13%
Yes, to help get our lab's inventions into operational use by the Warfighter	2	13%
Yes, to benefit industry, but that's not our primary focus	2	13%
Yes, if it supports the defense mission	1	6%
Yes, because it can lead to cost savings for DoD	1	6%
No, because not many DoD inventions are licensed to industry	1	6%
No, because not much DoD funding is allocated to that effort and the low level of funding is indicative of its importance	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 2: ***What do you see as the main purpose of protecting lab inventions and transferring them to industry?***

The answers to this question were coded into 10 unique thematic responses:

Code	Count	Frequency
Gets DoD inventions into production so DoD can procure them to benefit the U.S. Warfighter	5	31%
Leverages private-sector capabilities, resources, and ingenuity for commercialization of dual-use technologies	4	25%
Engages industry to help support the defense mission	4	25%
Keeps DoD from having to pay twice for the inventions, which could occur if DoD doesn't patent its inventions and someone else does	4	25%
Benefits the U.S. economy and provides a better return on investment to the American taxpayer	3	19%
Creates an opportunity to recognize and reward the inventors	2	13%
Allows the government to control the dissemination of its inventions to ensure the maximum social or military benefit	2	13%
Spurs innovation and entrepreneurship, which benefits U.S. technological competitiveness	1	6%
Helps the U.S. maintain its technological competitiveness	1	6%
No response	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 3: ***Do you think that your S&Es are doing an adequate job of disclosing their inventions?***

Answer	#	%
Yes	9	56%
No	7	44%
Total	16	100%

The qualitative answers to this question were coded into nine unique thematic responses:

Code	Count	Frequency
Yes, but there is room for improvement	4	25%
S&Es need more education and training on the invention disclosure process	3	19%
Yes, in part because of the incentives we are providing for invention disclosures	3	19%
No, they are not doing an adequate job	3	19%
No explanation	2	13%
What is being disclosed is only a small percentage of the total number of DoD lab inventions	1	6%
S&Es are focused on solving a problem and view IP protection as a distraction	1	6%
No, because we don't have the staff or patent budget to support our S&Es in protecting their inventions	1	6%
Yes, we've made this part of our lab culture	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 4: ***If not, how would you suggest motivating S&Es to do a better job of disclosing their inventions?***

The qualitative answers to this question were coded into 11 unique thematic responses:

Code	Count	Frequency
Reward S&Es for invention disclosures and issued patents	8	53%
Provide better training to S&Es on the importance of IP protection and T2 to the defense mission	8	53%
Make it easy for S&Es to disclose their inventions by providing substantial assistance	3	20%
Make S&Es aware that they will receive a substantial portion of any licensing revenues	2	13%
Communicate to S&Es that patents and T2 success can help protect their lab from BRAC	1	7%
Have lab leadership emphasize the importance of IP protection to the defense mission	1	7%
Provide better education and training on how to recognize inventions	1	7%
Develop more inclusionary policies to engage women and minority S&Es in IP development, protection, and T2	1	7%
Provide more staff and financial resources for IP protection	1	7%
Do a better job of promoting our patented inventions outside of the lab	1	7%
No response given	1	7%

Total does not equal 100% because each complete answer may include multiple themes.

Question 5: ***Do you view transferring your lab's inventions to industry as a legal obligation or a DoD requirement?***

Answer	#	%
Yes, it's both	7	44%
Yes, but only one of these	3	19%
No, neither	4	25%
Not sure	2	6%
Total	16	100%

The 15 answers to this question were coded into seven unique thematic responses:

Code	Count	Frequency
It's both a legal obligation and a DoD requirement	6	40%
It's both a legal obligation and a DoD requirement, but it's an unfunded mandate	1	7%
It's neither a legal obligation nor DoD requirement	3	20%
T2 is more of an objective than a legal obligation or DoD requirement	1	7%
It's a DoD requirement but not sure if it's a legal obligation	2	13%
It's a legal obligation but not a DoD requirement	1	7%
Not sure	1	7%

Total does not equal 100% because of rounding.

Question 6: ***Are CRADAs with industry and universities important at your lab? If so, how or why are they important?***

Answer	#	%
Yes	15	94%
No	1	6%
Total	16	100%

The qualitative answers to this question were coded into six unique thematic responses:

Code	Count	Frequency
They enable us to leverage the expertise and resources of the outside innovation ecosystem to develop new technology for the defense mission	10	67%
They enable us to conduct collaborative R&D with outside entities in a legally protected environment	2	13%
They enable us to evaluate outside technologies for U.S. military application	2	13%
They help advance knowledge within the lab's S&E community	2	13%
They allow us to cover the use of lab equipment without liability	1	7%
We haven't done many CRADAs	1	7%

Total does not equal 100% because each complete answer may include multiple themes.

Question 7: ***Are CRADAs an important way to develop new technology for the U.S. Warfighter?***

Answer	#	%
Yes	15	94%
Not sure	1	6%
Total	16	100%

The qualitative answers to this question were coded into eight unique thematic responses:

Code	Count	Frequency
Yes, they allow us to evaluate outside technologies for our mission needs	5	33%
Yes, they allow us to leverage outside parties to develop new technologies to support the U.S. Warfighter	4	27%
Yes, no explanation	3	20%
Yes, but they are not widely used at our lab	2	13%
Yes, but establishing CRADAs is a slow process that needs to be streamlined and made more flexible	1	7%
Yes, they help us advance the TRL of our lab technologies	1	7%
We don't really know because we lose sight of the CRADA-subject technology after the CRADA ends	1	7%
Yes, they help our S&Es keep current with the state-of-the-art in science and technology	1	7%

Total does not equal 100% because each complete answer may include multiple themes.

Question 8: ***What could DoD do to entice industry to collaborate more fully with DoD labs on developing new technology for the Warfighter?***

The answers to this question were coded into 16 unique thematic responses:

Code	Count	Frequency
Make it quicker and easier for industry to work with DoD labs by streamlining T2 agreements and the T2 process	3	19%
Establish programs to financially incentivize companies to engage with DoD, such as the former Dual Use Science and Technology (DU S&T) Program	3	19%
Do a better job of publicizing opportunities to collaborate with DoD on developing new technologies	3	19%
Strengthen mechanisms to protect private-sector firms' intellectual property if they collaborate with DoD	2	13%
Promote collaborating with DoD on development of dual-use technologies by emphasizing that DoD may be a major customer for the resulting technologies	2	13%
Expand use of OTAs	2	13%
We don't need to entice industry; they already mostly come to us	1	6%
Strengthen the position of T2 in the DoD acquisition process	1	6%
Not sure	1	6%
Make it easier for startup companies and entrepreneurs to present their innovations and technology concepts to DoD	1	6%
Make greater use of the National Security Innovation Network to partner with academic and industry innovators	1	6%
Make greater use of programs like the Commercial Technologies for Maintenance Activities (CTMA) awards to the National Center for Manufacturing Sciences to engage innovative companies	1	6%
Make greater use of PIAs	1	6%
Expand use of DoD briefings to industry on its technology development projects and needs	1	6%
Establish mechanisms to strengthen communications between S&Es, industry, and the acquisition community to facilitate technology transition	1	6%
Establish mechanisms to incentivize venture capital firms to support innovative startup companies that develop defense-related technologies	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 9*: Are you incentivized in your performance reviews to try to transition your lab's new technologies to the Warfighter?*

Answer	#	%
No	8	50%
Yes	7	44%
No response	1	6%
Total	16	100%

The qualitative answers to this question were coded into six unique thematic responses:

Code	Count	Frequency
It is not a rated element in our performance evaluations	8	50%
Yes, however it is only indirectly measured and not given any priority	8	50%
Yes, transition is recognized as a key part of the mission	1	6%
Yes, it is explicitly part of our performance evaluations	1	6%
Transitioning our lab's technologies is encouraged but not required	1	6%
There are no performance awards or national recognition tools for lab leadership in this area	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 10*: Do you ever interact with acquisition programs to make them aware of new technologies your lab has developed? If so, how?*

Answer	#	%
Yes	10	63%
No	6	38%
Total	16	101%

Total does not equal 100% because of rounding.

The “Yes” answers to this question were coded into eight unique thematic responses:

Code	Count	Frequency
I interact directly with PEOs to help them understand our lab's emerging technologies and to help drive new requirements	2	20%
No explanation given	2	20%
I occasionally interact with the acquisition community when certifications of lab technologies are required	1	10%
I interact indirectly with PMs, who interact with our technical departments to help guide new technology development	1	10%
I interact indirectly through the Navy's Capital Improvement Program (CIP)	1	10%
I interact indirectly through the Navy Innovative Science and Engineering (NISE) program	1	10%
I interact directly with the Air Force Life Cycle Management Center, which develops requirements and handles acquisition of weapon systems	1	10%
I have day-to-day interactions with the acquisition community, and we have annual meetings to brief each other on new technologies and technology requirements	1	10%

Question 11: ***How important is technology transfer in transitioning your lab's inventions into acquisition programs?***

The answers to this question were coded into six unique thematic responses:

Code	Count	Frequency
Very important	7	44%
Not very important; our lab rarely transitions its technologies to acquisition programs	4	25%
I don't know	2	13%
Somewhat important; it's one route to transition	1	6%
Not very important; T2 takes too long	1	6%
Important in certain technology areas	1	6%

Question 12: ***What are some examples of technologies that your lab has transitioned to DoD operational use?***

The answers to this question were coded into four unique thematic responses:

Code	Count	Frequency
Respondent was able to cite two or more examples	10	63%
Respondent could cite one example	2	13%
No response	2	13%
Respondent not aware of any examples	2	13%

Total does not equal 100% because of rounding.

Question 13: ***Have you encountered any of the following problems in getting your lab's new technologies into acquisition programs?***

13.1 Lack of a clearly defined process

Answer	#	%
Yes	9	56%
No	7	44%
Total	16	100%

13.2 The acquisition community does not seem receptive

Answer	#	%
Yes	12	75%
No	4	25%
Total	16	100%

The "Yes" answers to this question were coded into nine unique thematic responses:

Code	Count	Frequency
The acquisition community seems too risk averse to procure DoD lab technology	6	50%
Acquisition programs do not have the funds to mature DoD lab technology to the point of procurement	3	25%
Most DoD lab technologies have too low a TRL level to get into acquisition programs	2	17%
PMs are too short-term focused to be interested in DoD lab technologies	2	17%
No explanation given	2	17%
The acquisition process is too cumbersome to enable DoD labs to get their technologies into acquisition programs	1	8%
The difficulty of getting new certification approvals discourages acquisition of DoD lab technologies	1	8%
The acquisition community seems to trust defense contractors more than DoD labs	1	8%
The acquisition community is not receptive in part because they are not educated about how T2 can cost-effectively support the defense mission	1	8%

Total does not equal 100% because each complete answer may include multiple themes.

13.3 The FAR seems to discourage transition from DoD labs

Answer	#	%
No	10	63%
Yes	4	25%
Not sure	2	13%
Total	16	101%

Total does not equal 100% because of rounding.

The ”Yes” answers to this question were coded into three thematic responses:

Code	Count	Frequency
Because of FAR requirements, it takes far too long to get contracts awarded, which discourages transition from DoD labs	2	50%
FAR-trained contract officers are not knowledgeable on how to transition DoD lab technologies into acquisition programs	1	25%
No explanation given	1	25%

13.4 The technology transfer process is too slow or ineffective

Answer	#	%
Yes	9	56%
No	7	44%
Total	16	100%

13.5 Something else

Answer	#	%
No	13	81%
Yes	3	19%
Total	16	100%

The “Yes” answers to Question 13.5 were coded into three thematic responses:

Code	Count	Frequency
It is difficult for our lab to receive funding for prototyping	1	33%
The legal and security communities who review CRADAs need to be better trained	1	33%
Most DoD lab technologies have too low a TRL level to get into acquisition programs	1	33%

Question 14: ***How would you recommend fixing the problem(s) that you just identified?***

The answers to this question were coded into 17 unique thematic responses:

Code	Count	Frequency
The DoD acquisition and S&T communities need to work more closely together and coordinate funding for technology transition	3	19%
DoD needs better mechanisms to enable rapid procurement of new technology	3	19%
Require the acquisition community to receive training in how DoD T2 supports the defense mission and how to transition lab technologies to acquisition programs	3	19%
There needs to be a clearer and consistent process for getting DoD lab technologies into acquisition programs	1	6%
The DoD acquisition system should be required to procure DoD-developed technology when it meets a DoD mission need, whether from DoD labs or DoD SBIR-funded small businesses	1	6%
Provide better training and mentoring for ORTAs on patent licensing	1	6%
Not sure	1	6%
No explanation	1	6%
It would be difficult to fix because of the long tradition-bound DoD acquisition process	1	6%
DoD's T2 system needs to be better funded to enable it to develop strong and effective links with DoD acquisition programs	1	6%
DoD should provide more funding for maturation of DoD lab technologies in preparation for acquisition	1	6%
DoD should make its T2 and acquisition processes more standardized and streamlined	1	6%
DoD needs better internal communications, so the acquisition community knows what technology is available in DoD labs	1	6%
DoD labs should be given greater flexibility in how they can work with industry to get new lab technologies into acquisition programs	1	6%
Develop pilot programs focused on transitioning DoD lab technologies into acquisition programs	1	6%
Congress needs to change the FAR to facilitate the transition of DoD lab technologies into acquisition programs	1	6%
Centralize T2 within each service so ORTAs report directly to the service's T2 Program Office and receive their budget from that office	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 15: ***Do you think that CRADAs and license agreements with industry are an effective way to support the defense mission?***

Answer	#	%
Yes	16	100%
No	0	0%
Total	16	100%

The qualitative answers to this question were coded into six unique thematic responses:

Code	Count	Frequency
No explanation	10	63%
Yes, although they are not as effective as other ways to get new technology to the Warfighter	2	13%
Yes, they enable technologies to be either spun in or spun out of DoD labs to help support the Warfighter	1	6%
Yes, CRADAs more than licenses	1	6%
Yes, if labs employ best practices in establishing CRADAs and licenses in a timely way	1	6%
Yes, because they leverage industry's resources while protecting our rights	1	6%

Question 16: ***Could your lab's R&D goals and metrics be improved to better support the defense mission?***

Answer	#	%
Yes	14	88%
No	2	13%
Total	16	101%

Total does not equal 100% because of rounding.

The qualitative answers to this question were coded into 13 unique thematic responses:

Code	Count	Frequency
Not sure how	3	20%
While they could always be improved, they are already fairly effective	2	13%
We need R&D metrics that are more qualitative than quantitative and that assess impact	2	13%
R&D goals need to be harmonized across DoD, so all parties are on the same page	2	13%
Through better partnerships with industry	2	13%
We need to start using a "Transition Readiness Level" rather than a Technology Readiness Level when evaluating DoD lab technologies for acquisition	1	7%
We need to get away from R&D goals and metrics that are focused on how quickly funds are obligated and spent	1	7%
We could evaluate our effectiveness better using data analytic tools	1	7%
R&D goals need to become capability-focused and capability-driven	1	7%
R&D goals currently are mostly short-term goals; we also need better long-term goals	1	7%
Our R&D goals and metrics already effectively support the defense mission	1	7%
No explanation given	1	7%
For every quantitative metric, we need an accompanying qualitative metric	1	7%

Total does not equal 100% because each complete answer may include multiple themes.

Question 17*: What could DoD do to enable DoD labs to have a bigger impact on the defense mission?*

The answers to this question were coded into 19 unique thematic responses:

Code	Count	Frequency
Do a better job of tracking the impacts of DoD lab technologies on the defense mission	3	19%
Provide more funding and resources (including greater support for PIAs) to enable transitioning DoD lab inventions to DoD operational use	3	19%
Streamline processes to get DoD lab technologies transferred and transitioned more rapidly	2	13%
Give S&Es flexibility to pursue their defense mission-related ideas	2	13%
Do a better job of integrating lab R&D activities with Warfighter needs	2	13%
Track lab inventions to determine how well they align with DoD's RDT&E goals	1	6%
Provide better training to the DoD acquisition community in how to transition DoD lab technologies to acquisition programs	1	6%
Evaluate lab leaders on their effectiveness in generating, transferring, and transitioning lab inventions in support of the DoD mission	1	6%
Provide more funding for S&Es to attend important technology conferences to facilitate contacts and collaborations with industry	1	6%
Provide better education within DoD about how DoD labs and T2 support the defense mission	1	6%
Prioritize fixing the biggest two or three problems, rather than studying all of them	1	6%
Develop a centralized database of all DoD IP so that both labs and the acquisition community can see the DoD inventions in the patenting pipeline that could be further developed and/or acquired	1	6%
Make sure that DoD leadership understands what qualifies as a DoD "lab" that can use T2 authorizations and tools	1	6%
Improve education and training on T2 for lab leadership so they understand how T2 can significantly contribute to the defense mission	1	6%
Establish better metrics to evaluate the impact of DoD labs on the defense mission	1	6%
Delegate more decision authority to the local lab level	1	6%
Change the mindset; recognize that private industry is now the leader in developing new technology, place greater emphasis on spin-in T2	1	6%
No improvements needed: T2 already is doing what it's supposed to do	1	6%
Not sure	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 18: ***How could DoD make technology transfer more effective at supporting the defense mission?***

The answers to this question were coded into 14 unique thematic responses:

Code	Count	Frequency
Give priority to T2 activities that support the defense mission	3	19%
Increase funding to enable DoD to expand evaluation of new private-sector innovations for DoD application	2	13%
DoD needs to establish a centralized database to provide visibility into its entire patent portfolio at the service or DoD enterprise level	2	13%
The DoD acquisition system should be required to procure DoD-developed technology when it meets a DoD mission need, whether from DoD labs or DoD SBIR-funded small businesses	1	6%
Monitor T2 agreements after they are signed to better understand outcomes and impacts	1	6%
Make the DoD acquisition system less risk-averse and more willing to take a chance on novel game-changing solutions	1	6%
Increase funding to enable S&Es to participate more fully in transition of new lab-developed technology	1	6%
DoD should give greater priority to T2, along with the budget and staff to adequately support it	1	6%
DoD needs to change its patenting culture from protecting IP for defensive purposes to protecting IP to serve strategic RDT&E goals	1	6%
DoD needs better ways to make acquisition community aware of the technologies available in DoD labs	1	6%
DoD needs better mechanisms to enable rapid procurement of new technology	1	6%
DoD lab leadership needs to be educated about how T2 authorities and tools can be effectively used to support the defense mission	1	6%
DoD should publish a "best T2 practices" manual for use by all DoD labs	1	6%
No response	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

DoD Acquisition Community

Coded Interview Responses

Question 1: ***How important is the DoD laboratory system in generating new technologies for acquisition programs and Warfighter use?***

The answers to this question were coded into four unique thematic responses:

Code	Count	Frequency
Important for generating new defense-related technologies and providing solutions for the Warfighter	13	76%
Not very important in generating new technologies for our acquisition programs	5	29%
Less important than industry in generating new technologies for our acquisition programs	1	6%
Important because labs have closer contacts with technology advances in industry than the acquisition community does	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 2: ***Are you aware of any technologies that were developed in DoD labs and then transitioned into DoD acquisition programs?***

Answer	#	%
Yes	17	100%

Question 3: ***What are some examples of DoD-developed technologies that were transitioned to acquisition programs?***

The answers to this question were coded into two unique thematic responses:

Code	#	%
Respondent was able to provide one or more examples	9	53%
Respondent was aware of examples in other programs	8	47%

Question 4: ***Does technology transfer, whether through license agreements or CRADAs, play an important role in transitioning DoD lab inventions to DoD operational use?***

Answer	#	%
Not Sure	6	35%
Yes	6	35%
No	5	29%
Total	17	99%

Total does not equal 100% because of rounding.

Question 5: ***Could the role of technology transfer in supporting the defense mission be increased or improved? If so, how?***

Answer	#	%
Yes	16	94%
Not Sure	1	6%
Total	17	100%

The answers to Question 5 were coded into 19 unique thematic responses:

Code	#	%
Change the system so acquisition programs give greater priority to acquiring technology from companies that have either licensed DoD lab technologies or co-developed new technologies with DoD labs	3	18%
Provide better education and training to acquisition program and project managers on the strengths and advantages of using T2 mechanisms to support the defense mission	2	12%
Provide financial incentives to the private sector to engage in T2 agreements to develop dual-use technology that DoD can procure	2	12%
Provide more funding to DoD labs to advance the TRL level of promising DoD lab technologies and get them through the "valley of death"	2	12%
Not sure	2	12%
Change from the requirement-based system to a system that emphasizes operational capability needs	1	6
Delegate authority to establish CRADAs to senior acquisition program managers, not just labs, to co-develop new technology to support the defense mission	1	6%
Change FAR so DoD can sole source the technology developed in its own labs or funded industry to develop through SBIR or other programs	1	6%
Make sure that CRADAs can be easily modified as technology needs change	1	6%
Provide DARPA-like funded challenges to the private sector to solve critical DoD technology needs	1	6%
T2 should be the main mechanism by which DoD acquires its new technologies	1	6%
Increase the trust level between DoD labs and DoD acquisition programs	1	6%
Change the system so DoD labs, PMs, requirements generators, and financial folks are synchronized into a strategic plan from the start	1	6%
Expand the use of Technology Transition Agreements (TTAs) between DoD labs and acquisition programs	1	6%
Expand use of "spin-in" CRADAs whereby DoD labs that do sustainment acquire innovative technology from industry	1	6%
Educate DoD lab personnel so they understand PM requirements and milestone roadmaps	1	6%
Create many more positions for "advanced technology integrators" who would help acquisition programs learn about and acquire new technologies from labs	1	6%
Incentivize DoD labs to develop new technologies more rapidly	1	6%
Establish better mechanisms to enable DoD labs to get feedback from end-users in the U.S. military on technology needs and requirements	1	6%
Change the system so acquisition programs don't have to spend money so rapidly, which incentivizes them to work with industry rather than DoD labs	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 6: ***Do you ever interact with DoD labs to become aware of the new technologies they are developing? If so, how?***

Answer	#	%
Yes	14	82%
No	3	18%
Total	17	100%

The "Yes" answers to this question were coded into seven unique thematic responses:

Code	#	%
Through multiple avenues	8	47%
Through personal contacts with labs	2	12%
Through annual capability function team (CFT) reviews	2	12%
Through annual program reviews	1	6%
Through ad hoc methods that are not very effective	1	6%
Through interaction with Chief Scientists	1	6%
Through our acquisition program S&T advisors	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 7: *Have you encountered any of the following problems in getting new DoD lab technologies into acquisition programs?*

7.1 Lack of a clearly defined process

Answer	#	%
Yes	11	65%
No	6	35%
Total	17	100%

The eleven “Yes” answers to Question 7.1 were coded into three unique thematic responses:

Code	#	%
There is a lack of a standard, clearly defined, well-understood process	11	100%
There is a general lack of communication and collaboration between DoD labs and acquisition programs	2	18%
The update of the DoD 5000 series is a start, but doesn't go nearly far enough	1	9%

Total does not equal 100% because each complete answer may include multiple themes

7.2 The labs do not seem to be interested or receptive

Answer	#	%
No	12	70%
Yes	4	24%
Not Sure	1	6%
Total	17	100%

The “Yes” answers to this question were coded into five unique thematic responses:

Code	#	%
DoD lab personnel are not evaluated on whether their lab technologies transition to DoD operational use, so this is not a major concern	2	50%
DoD labs lack a strong incentive to transition maturing technologies to program offices	1	25%
There is a general lack of communication, coordination, and collaboration between DoD labs and acquisition programs	1	25%
DoD labs lack personnel who are knowledgeable about facilitating acquisition of new lab technologies	1	25%
DoD labs lack a strong incentive to transition maturing technologies to program offices	1	25%

Total does not equal 100% because each complete answer may include multiple themes.

7.3 The FAR seems to discourage technology transition from DoD labs

Answer	#	%
No	9	53%
Yes	7	41%
Not Sure	1	6%
Total	17	100%

The “Yes” answers to this question were coded into three unique thematic responses:

Code	#	%
The FAR process takes too long and puts too many hurdles in the way	7	100%
The update of the DoD 5000 series is a start, but doesn't go nearly far enough	4	57%
FAR-based RFPs rarely specify a specific technology solution, which encourages vendors to use their own proprietary technologies, rather than a specific lab technology	1	14%

Total does not equal 100% because each complete answer may include multiple themes.

7.4 The T2 process is too slow or ineffective

Answer	#	%
Yes	8	47%
Not Sure	5	29%
No	4	24%
Total	17	100%

The “Yes” answers to Question 7.4 were coded into seven unique thematic responses:

Code	#	%
Technology Transition Agreements (TTA) require too many high-level signatures	3	38%
DoD labs lack trained personnel to undertake the substantial effort of preparing the necessary documentation to support transition of new technologies to acquisition programs	1	13%
JCIDS and POM processes ties the PMs hands and take a minimum of four years to get funding and three years to develop and deploy	1	13%
Senior leaders generally want faster transition than typically occurs when DoD labs are involved	1	13%
PMs are too risk averse to engage in transition that involves T2	1	13%
T2 typically occurs long after the end of a technology development project	1	13%
There is a lack of timely and adequate funding to help transition unexpected lab technology breakthroughs	1	13%
It is less risky to contract with a defense contractor than to try to get DoD lab technologies into acquisition programs	1	13%

Total does not equal 100% because each complete answer may include multiple themes.

7.5 Something else

Answer	#	%
Yes	11	65%
No	6	35%
Total	17	100%

The “Yes” answers to Question 7.5 were coded into five unique thematic responses:

Code	#	%
There is a general lack of communication, coordination, and collaboration between DoD labs and acquisition programs	8	73%
DoD labs often lack an end-user representative who is able or willing to support transition	1	9%
We don't have the personnel needed to undertake successful transition of DoD lab technologies into acquisition programs	1	9%
It is less risky to execute a contract with a defense contractor than to try to get DoD lab technologies into acquisition programs	1	9%
There is a lack of timely and adequate funding that can be used to help transition unexpected lab technology breakthroughs	1	9%

Total does not equal 100% because each complete answer may include multiple themes.

Question 8: ***How would you recommend fixing the problem(s) that you just identified?***

The answers to this question were coded into 13 unique thematic responses:

Code	#	%
Not sure	6	35%
Establish better alignment of R&D projects and acquisition program needs through increased communications, to enable greater transition of DoD lab technologies	2	12%
Establish early and regular interactions between DoD labs and acquisition programs to encourage more transition from the labs	2	12%
Improve and standardize Technology Transition Agreements (TTAs) across DoD	2	12%
Create a Transition Directorate to facilitate transition of DoD lab technologies to acquisition programs	1	6%
Develop a standard contract to enable DoD acquisition programs to procure small production quantities of DoD lab-developed technologies for evaluation in the field, with the option to expand purchases if the technology performs well	1	6%
DoD should establish an adequate pot of 6.4 funding that acquisition programs can compete for just prior to the execution year	1	6%
DoD should use R&D goals to design R&D projects, rather than putting design goals around existing R&D projects	1	6%
Establish a clear process for transitioning maturing DoD lab technologies to a program office, using streamlined acquisition authorizations (DoDI 5000.80 and 5000.81) where justified	1	6%
Establish regular meetings between DoD labs and OEMs	1	6%
Establish stronger connections between SBIR companies and OEMs (original equipment manufacturers)	1	6%
Increase the use of AI and data visualization tools, to help the acquisition community source technologies being developed in the DoD labs	1	6%
Provide more education and training for the acquisition community on IP and T2 mechanisms	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Question 9: ***Are you incentivized in your performance reviews to transition DoD lab inventions into acquisition programs?***

Answer	#	%
No	14	82%
Yes	3	18%

Question 10: ***Could DoD's R&D goals and metrics be improved to better support the defense mission? If so, how?***

Answer	#	%
Yes	14	82%
No	3	18%
Total	17	100%

The "Yes" answers to this question were coded into nine unique thematic responses:

Code	#	%
Through placing greater emphasis on achieving an impact on the defense mission when creating R&D goals and metrics	7	50%
Personnel need to be incentivized by performance reviews to undertake the additional work needed to transition DoD lab technologies to acquisition programs	6	43%
Through documenting the many technology transitions that are occurring through T2 and support agreements using DD Form 1144, which would encourage better alignment between DoD's R&D goals and metrics in support of the defense mission	2	14%
Through providing more stable, longer-term funding for R&D projects	1	7%
Through better alignment of R&D goals with acquisition community needs	1	7%
Through better supporting the DoD T2 function using R&D funding	1	7%
Establish stronger connections with the end-user community to better align R&D goals and metrics with U.S. military needs and requirements	1	7%

Total does not equal 100% because each complete answer may include multiple themes.

Question 11: ***Could DoD's acquisition programs be improved to better support the transition of DoD lab-developed technology? If so, how?***

Answer	#	%
Yes	17	100%

The answers to this question were coded into 18 unique thematic responses:

Code	#	%
Not sure	4	24%
By establishing frequent and regular mechanisms for DoD labs to communicate their new technology developments with acquisition program managers	3	18%
Through establishing an investment roadmap for DoD lab technology transfer and transition	2	12%
Through better alignment of DoD lab R&D goals with acquisition programs	2	12%
By providing better education to DoD lab personnel on how the DoD acquisition process works	2	12%
By reducing risks for acquisition PMs to try to transition DoD lab technologies	2	12%
DoD acquisition managers need to be incentivized to support the transition of DoD lab-developed technologies and not punished for failed attempts	2	12%
Through early engagement with industry to brief them on U.S. military needs and requirements	1	6%
Establish a process akin to spiral development to allow for continuous innovation and product improvement	1	6%
By providing more stable, longer-term funding the acquisition managers can use to transition DoD lab technologies	1	6%
Through revising the POM process, which is tedious, slow, and somewhat antiquated and limits the amount of technology that can be transitioned	1	6%
By increasing the number of DoD technologies that are licensed to industry	1	6%
Through increasing cross-organization funding to engage lab technology expertise to meet acquisition program needs	1	6%
Each product center should have a Chief Scientist to act as an advisor and work with DoD labs to pull in lab-developed technologies	1	6%
By adding personnel with appropriate technical expertise to serve as liaisons to DoD labs	1	6%
By making it easier for industry to learn of DoD technologies available for licensing	1	6%
Through expanded use of Technology Transition Agreements (TTAs)	1	6%
Through providing financial incentives to industry to engage in T2 agreements with DoD labs to co-develop and/or commercialize dual-use technologies	1	6%
Through greater use of end-user representatives to link DoD acquisition programs with DoD lab technologies	1	6%

Total does not equal 100% because each complete answer may include multiple themes.

Private Sector

Coded Interview Responses

Question 1: ***How did you learn about the opportunity to engage with the Dept. of Defense through a T2 agreement (license or CRADA)?***

The answers to this question were coded into seven unique thematic responses:

Code	Count	Frequency
Through the lab's S&Es	9	26%
Through a previous relationship with DoD or the lab	9	26%
Through TechLink	8	24%
Through the lab's T2 office	4	12%
The company founder was the technology's inventor at the lab	2	6%
Through internet research	2	6%
Through an industry trade association	1	3%

Total does not equal 100% because each complete answer may include multiple themes.

Question 2: ***Was establishing the agreement a smooth and timely process?***

Answer	#	%
No	22	65%
Yes	12	35%
Total	34	100%

Question 3: ***If not a smooth and timely process, which of the following was a problem?***

3.1 It was difficult to figure out the process

Answer	#	%
Yes	25	74%
No	9	26%
Total	34	100%

3.2 The process seemed too bureaucratic

Answer	#	%
No	18	53%
Yes	16	47%
Total	34	100%

3.3 It took too long to establish the agreement

Answer	#	%
Yes	17	50%
No	17	50%
Total	34	100%

3.4 The terms were not favorable to your company

Answer	#	%
No	21	62%
Yes	13	38%
Total	34	100%

3.5 The lab's T2 personnel were not very helpful

Answer	#	%
No	26	76%
Yes	8	24%
Total	34	100%

3.6 The lab's lawyers were difficult to work with

Answer	#	%
No	27	79%
Yes	7	21%
Total	34	100%

3.7 Something else

Answer	#	%
No	26	76%
Yes	8	24%
Total	34	100%

The “Yes” answers to this question were coded into seven unique thematic responses:

Code	Count	Frequency
The lab inventors either were not helpful or were openly hostile	3	38%
It was continually difficult to get ahold of someone at the lab to answer questions about the T2 process or agreement	1	13%
There were steps required to complete the CRADA project that were not mentioned in the CRADA document	1	13%
The licensee was never allowed to speak with the technology inventors	1	13%
The CRADA PM was difficult to work with and not interested in the CRADA project	1	13%
The technology needed a lot more development than we were led to believe by the DoD inventors	1	13%
The licensee was not given enough information to enable use or commercialization of the DoD invention	1	13%

Total does not equal 100% because each complete answer may include multiple themes

Question 4: ***How would you recommend that DoD fix the problem(s) you just identified?***

The answers to this question were coded into 25 unique thematic responses:

Code	Count	Frequency
DoD needs to standardize and streamline its T2 processes, so they are more readily understood and easy to follow by industry, especially by small, non-traditional defense contractors	11	32%
DoD labs need to develop stronger connections with the acquisition community and end users to help pave the way to transition	6	18%
No problems that need to be fixed	5	15%
T2 personnel need to be given business and entrepreneurship training and education so they understand private-sector needs and perspectives	4	12%
DoD needs to recognize T2 as an essential part of the defense mission and give greater priority to T2	4	12%
DoD needs to make it easier for DoD licensees or CRADA partners to transition new dual-use technologies or products to DoD acquisition programs	4	12%
In cases where licensed DoD lab technologies meet critical military needs, DoD needs to provide support to licensees after the agreements are signed to facilitate successful transition	3	9%
Not sure	2	6%
The ORTA needs to be given greater power and authority from the commanding officer to ensure that S&Es cooperate with T2	1	3%
ORTAs need to look beyond the execution of T2 agreements to the ultimate desired outcomes and impacts	1	3%
Make greater use of partnership intermediaries as objective, third-party facilitators	1	3%
Give S&Es greater authority to initiate CRADAs	1	3%
Find creative ways to speed up negotiation of T2 agreements, such as by using online meeting platforms	1	3%
DoD should make greater use of OTAs, which are more flexible and business friendly	1	3%
DoD needs to use shorter and simpler agreements where appropriate, such as material transfer agreements instead of CRADAs to transfer material samples and information	1	3%

DoD needs to provide the complete data package to the licensee to enable the licensee to practice and commercialize the licensed invention	1	3%
DoD needs to overcome the reluctance of defense contractors to subcontract with companies that have developed new defense-related products through license agreements or CRADAs	1	3%
DoD needs to make it easier for industry CRADA partners to gain access to the lab	1	3%
DoD needs to make it clearer what companies need to do to close out their CRADA projects	1	3%
DoD needs to improve the language in its license agreements and CRADAs to make it more explicit that DoD won't share company IP with competitors	1	3%
DoD needs to establish much better alignment between DoD lab R&D goals and activities and DoD Warfighter needs	1	3%
DoD needs to establish clearer rules on whether licensees of DoD lab technologies can be required to pay royalties on sales to the U.S. government	1	3%
DoD needs to establish clear-cut guidelines and procedures on what DoD lab employee can and cannot do to license DoD lab technologies, so they can commercialize these technologies after they leave government employment	1	3%
DoD labs need to figure out a way to make the business communities in their regions much more aware of new DoD lab technologies, perhaps with more prominent lab technology days	1	3%
DoD CRADA templates should be written to allow greater flexibility in CRADA projects	1	3%

Total does not equal 100% because each complete answer may include multiple themes.

Question 5*: If you had a license agreement, what was the main value to your company of licensing government-developed technology?*

The answers to this question from the 21 respondents with license agreements were coded into six unique thematic responses:

Code	Count	Frequency
Time and money savings in the R&D and product development process	9	43%
Licensing from DoD opened the door to U.S. military sales	9	43%
The licensed technology enabled us to develop a successful new product	6	29%
The DoD lab origin of the technology gave a high degree of confidence to our investors and/or customers	4	19%
Leveraging the creativity, expertise, effort, and facilities of DoD's world-class research enterprise	2	10%
R&D risk reduction by acquiring a technology that had already been patented and reduced to practice	1	5%

Total does not equal 100% because each complete answer may include multiple themes.

Question 6*: Were there any downsides to licensing from the government? If so, please explain.*

Answer	#	%
Yes	14	67%
No	7	33%
Total (with licenses)	21	100%

The “Yes” answers to Question 6 were coded into 12 unique thematic responses:

Code	Count	Frequency
We experienced difficulties selling the licensed technology to DoD, despite their need for this technology	4	29%
Venture capital firms don't like some of the clauses in standard license agreements, such as government use and march-in rights and U.S. manufacture requirements	2	14%
It was difficult to change the terms of the license agreement later, based on our experience developing the technology and evolving market conditions	2	14%
DoD lab wouldn't allow access to the inventor for follow-up questions after the license agreement was signed	2	14%
The lab would not give us an exclusive license to the technology, even though we are a Fortune 500 company and had a compelling need for an exclusive license	2	14%
We had to forego more profitable business opportunities to keep on selling the licensed technology to the government out of a sense of obligation	1	7%
The lab stopped communicating with us and terminated the agreement	1	7%
We felt that the license agreement did not adequately protect our existing IP	1	7%
We had trouble getting the technical data from the lab that was needed to develop and commercialize the technology	1	7%
The lengthy and bureaucratic process, which doesn't recognize that for businesses, "time is money"	1	7%
The DoD inventors didn't like the fact that their lab licensed the technology and publicly disparaged both the technology and our company	1	7%
The licensed technology was not nearly as far along in development as the DoD inventors led us to believe, so the development costs were much greater than anticipated	1	7%

Total does not equal 100% because each complete answer may include multiple themes.

Question 7: ***If you had a CRADA, what were the advantages of collaborating with a DoD lab under that mechanism?***

The answers to this question from the 26 respondents with CRADAs were coded into 12 unique thematic responses:

Code	Count	Frequency
The collaboration helped us be more successful in our R&D project	7	27%
Gaining access to unique expertise and research facilities	7	27%
The CRADA project opened the door to U.S. military sales	4	15%
Continuing access to the inventors to help successfully commercialize the technology	4	15%
The CRADA allowed us to share IP and information with the DoD under a legally protected environment	3	12%
Developing an ongoing strong relationship with the DoD S&Es	3	12%
This collaboration with the DoD lab made us more confident in proceeding with our R&D project	2	8%
This collaboration with the DoD lab enabled us to establish credibility with other government lab and customers	2	8%
This collaboration helped us to understand the DoD marketplace for new technology	2	8%
This CRADA project enabled us to establish a successful small business	1	4%
The CRADA terms didn't give us the flexibility that we needed to be highly successful with our R&D effort	1	4%
The CRADA project cost us a lot more than the amount stated in the CRADA	1	4%

Total does not equal 100% because each complete answer may include multiple themes.

Question 8: ***Were there any downsides to collaborating with DoD under a CRADA? If so, please explain.***

Answer	#	%
Yes	15	58%
No	11	42%
Total	26	100%

The "Yes" answers to this question were coded into eight unique thematic responses:

Code	Count	Frequency
The DoD S&Es were not very responsive or cooperative	5	33%
We experienced difficulties selling the CRADA-developed technology to DoD, despite their need for this technology	3	20%
The CRADA took far too long to establish	3	20%
The CRADA project cost us a lot more than the amount listed in the CRADA	2	13%
We were required to do things to complete the CRADA project that were not spelled out in the CRADA document	1	7%
We felt that the CRADA did not adequately protect our existing IP	1	7%
The ORTA was not very helpful in helping to address our concerns about the CRADA terms	1	7%
The DoD lab should have used a simple material transfer agreement; the CRADA document was far too long, and many terms were not relevant to the situation	1	7%

Total does not equal 100% because each complete answer may include multiple themes.

Question 9: ***Have you had more than one CRADA or license agreement with DoD?***

Answer	#	%
Yes	23	68%
No	11	32%
Total	34	100%

The ”Yes” answers to this question were coded into two thematic responses:

Code	Count	Frequency
Multiple license agreements and CRADAs	15	65%
Two license agreements or CRADAs	8	35%

Question 10: ***Would you be willing to enter into future CRADAs or license agreements with DoD?***

Answer	#	%
Yes	33	97%
Not Sure	1	3%
Total	34	100%

Question 11: ***If not, why not?***

The “Not Sure” answer to Question 10 was coded as follows:

- The DoD T2 process is currently too dysfunctional and would need to change for me to consider engaging in it again

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Appendix 7:
Complete List of Recommendations and Metrics

The complete list of recommendations generated by the project follows. It comprises a total of 232 recommendations, including 44 proposed new metrics. These recommendations are organized and sorted in four different ways. *First*, they are grouped according to the element in the T2 system to which they pertain: inputs, activities, outputs, intermediate outcomes, end outcomes, or impacts. *Second*, they are sorted into three different tiers, each tier indicating the relative difficulty of implementation. *Third*, they are ranked with scores from 1 to 4 to indicate the anticipated impact or benefit from their implementation (no recommendations were assigned a score of "5"). *Fourth,* they are assigned labels to indicate which of the following six functional categories they address: strategy and policies; resources; education and training; processes and procedures; acquisition; or metrics.

Inputs

Tier I: Low-to-no-cost solutions that can be most readily implemented

Recommendation	Rank	Category
Establish a strong DoD T2 strategy that extends from initial inputs to end outcomes, with measurable goals for each major phase, and that focuses on ultimately achieving substantial impacts on the defense mission. This should be a long-term strategy with long-term goals, which is reviewed every 2-3 years to implement changes as needed.	1	Strategy & Policies
Establish DoD-wide standard T2 metrics that extend from T2 inputs and activities through T2 outputs, outcomes, and impacts on the defense mission.	1	Strategy & Policies; Processes & Procedures Metrics
Establish metrics that align DoD lab R&D goals with established military needs, requirements, or gaps.	1	Strategy & Policies; Processes & Procedures; Metrics
Provide adequate basic and advanced training in T2 for all DoD T2 personnel, so they are confident and proficient in their jobs, and	1	Education & Training; Metrics

establish metrics to track which and how many personnel have received this training.		
Provide adequate basic and advanced training in T2 and IP protection for all legal staff supporting the DoD T2 function, so they are confident and proficient in their jobs, and establish metrics to track which and how many personnel have received this training.	1	Education & Training; Metrics
Establish and fully document T2 procedures and processes at all DoD labs.	1	Strategy & Policies; Processes & Procedures
Provide mandatory training to S&Es on the importance of IP protection and T2 in transitioning DoD lab technologies to the U.S. Warfighter, explaining what can be accomplished with the various T2 mechanisms, that they will receive a substantial portion of any licensing revenues, and that achieving patents and T2 success can help protect their lab from BRAC.	1	Education & Training
For S&Es engaged in R&D, make participation in IP protection, T2, and transition part of their annual performance reviews, to ensure their participation in these activities, and establish metrics to encourage this participation.	1	Strategy & Policies; Processes & Procedures; Metrics
On annual performance reviews for S&Es, DoD should treat being an inventor on an issued patent as equivalent in value to being an author on a publication.	1	Strategy & Policies; Processes & Procedures
Secure top-level support for IP protection and T2 across DoD by ensuring the wide dissemination of the revised DoD Instruction 5535.08, “DoD Technology Transfer (T2) Program,” to DoD leadership, followed by educational sessions in which this DoDI is explained.	1	Education & Training
Adequately educate DoD lab leaders and managers so they understand that T2 is a legal obligation for all government R&D labs and that they are specifically instructed by DoDI 5535.08 to regard T2 as an integral element of the DoD national security mission and as a key activity of all DoD labs, whose primary purpose is to get DoD-developed technology transferred to the private sector so it can be productized and commercialized to benefit the U.S. defense mission and national economy.	1	Education & Training

Fully educate lab leaders on the problems and pitfalls resulting from not adequately protecting DoD IP, such as loss of data rights, loss of rights to freely use DoD lab inventions if other parties (such as defense contractors) patent these inventions, and increased costs if DoD has to procure products based on its own inventions from the outside parties holding the patents to these inventions.	1	Education & Training
Establish strong incentives for DoD lab leadership to support IP protection and T2 at their labs, such as by making lab achievements in these areas part of their annual performance reviews and establishing metrics to measure these achievements.	1	Strategy & Policies; Processes & Procedures; Metrics; Acquisition
Make sure that DoD leaders, including leaders of sustainment centers, understand what qualifies as a DoD "lab" able to use T2 authorizations and how T2 mechanisms can assist them with their mission.	1	Strategy & Policies; Processes & Procedures
Encourage DoD lab leaders to position their T2 offices within the lab organization chart at a high enough level that they have the authority and visibility needed to be effective.	1	Strategy & Policies; Processes & Procedures
Train DoD lab personnel, especially lab leaders and managers, in how DoD's acquisition programs operate, how and when money is spent, what the key insertion points are, what funding is available, what is required to get lab technologies into acquisition programs, and the importance of meeting PM design goals. This training should be specific to the DoD component in which the DoD labs and acquisition programs are located.	1	Education & Training; Acquisition
Encourage DoD labs to use DoD FLEX-4 funds (formerly Section 219 funds) under 10 U.S.C. 2363 to adequately support technology transfer and transition. This is a potentially large source of funding that could substantially increase the funding available for DoD lab T2 and technology transition.	1	Processes & Procedures; Resources; Acquisition
Make clear to all DoD labs how they can use DoD FLEX-4 funds to support technology transfer and transition. For example, many labs are confused about whether these funds may only be used by DoD labs classified as Centers for Science, Technology, and Engineering Partnership (CSTEPs, formerly known as Science and Technology Reinvention Laboratories or STRLs) or all DoD labs; whether these funds may be used to cover the cost of CRADAs by DoD lab personnel; whether these funds may be used for T2; and how else these funds may be used. In addition, make sure labs understand	1	Strategy & Policies; Processes & Procedures; Resources; Acquisition

that in FY2017 the percent of the R&D funds available for FLEX-4 changed from "not more than three percent" to "not less than two percent and not more than four percent." Some labs are still using less than two percent for FLEX-4.		
Through education and training, change how DoD lab leaders, S&Es, and the acquisition community perceive T2, from the current perception of T2 as an unfunded Congressional mandate to foster economic development, to an important pathway to transition DoD lab technologies to the U.S. Warfighter. For example, DoD has many programs designed to help transition DoD lab technologies to DoD operational use; however, in DoD overviews of its transition programs, T2 is rarely mentioned. This needs to change.	1	Education & Training; Processes & Procedures; Acquisition
Provide specialized training in the IP protection process for software for all T2 and legal counsel and establish metrics to track which and how many personnel have received this training.	2	Education & Training; Metrics
Develop and widely disseminate a "best T2 practices" manual for use by all DoD labs.	2	Strategy & Policies; Processes & Procedures
Establish a "one stop" on-line portal for all DoD T2 training, so it is easy to find when needed.	2	Strategy & Policies; Processes & Procedures
Create a standard, comprehensive, customizable IP protection and T2 training module for ORTAs to deliver to S&Es at their labs, to improve the quality of this education and avoid the need for each ORTA to independently develop their own educational and training materials.	2	Processes & Procedures; Education & Training
Require DoD acquisition personnel to receive training in T2 through the Defense Acquisition University (DAU). This will include training in the strategic use of T2 mechanisms to support new technology development and technology transition, so that more DoD lab-developed technology can be transitioned and deployed to benefit the U.S. Warfighter.	2	Strategy & Policies; Processes & Procedures; Education & Training; Acquisition
Standardize Technology Transition Agreements (TTAs) across DoD or at least within DoD components.	2	Strategy & Policies; Processes & Procedures; Acquisition

Improve metric gathering by implementing a system that uses monthly and annual scorecards with benchmarks.	3	Strategy & Policies; Processes & Procedures; Metrics
Establish a specific job category for "T2 Professional" with a specific career path and different levels of certification (like a warranted contract officer) to elevate the profession and improve its standing and respect within the DoD hierarchy. A professional career path with an associated certification program is highly requested year after year by the T2 community and, if implemented, will reduce ORTA turnover, which is a systemic problem across DoD.	3	Strategy & Policies; Processes & Procedures
At labs where there are separate T2 and Partnerships offices, combine these two offices so they are better aligned with each other.	3	Processes & Procedures
Establish better data governance policies and systems covering how DoD labs should secure, protect, and utilize proprietary information, balancing the needs for privacy, cybersecurity, and proprietary interests in the data.	3	Strategy & Policies
Give basic business and entrepreneurship education and training to DoD lab T2 personnel and IP counsel so they better understand industry needs, perspectives, and concerns.	3	Education & Training
Modernize methods for all DoD T2 education and training, such as by establishing a YouTube channel on how to undertake specific T2-related tasks (equivalent to YouTube videos on home repair).	3	Processes & Procedures; Education & Training
Establish clear-cut DoD-wide guidelines and procedures on when and how DoD S&Es and other lab employees can license DoD lab technologies and commercialize these technologies after they permanently leave government employment.	3	Processes & Procedures
Educate military officers on the importance of IP protection, the problems that can result from improperly protected IP, and how T2 can benefit the defense mission. This is especially important because many officers eventually end up in acquisition programs or leadership positions in the DoD lab system. This IP and T2 training for military officers should become an integral part of the training program at the War Colleges.	3	Education & Training

Emphasize to DoD labs that the primary purpose of licensing DoD lab inventions to industry is to achieve final development and practical application of these inventions to benefit the U.S. economy and defense mission; it is not to generate licensing revenues for DoD. Accordingly, licensing fees and royalty terms should be kept as low as reasonable to incentivize licensing of these inventions.	3	Strategy & Policies; Processes & Procedures
Make it easier for industry to learn of DoD technologies available for licensing, such as by establishing a system whereby companies get alerted if a new invention is available for licensing in their area of interest.	3	Processes & Procedures
Improve the language in license agreements and CRADAs to make it more explicit that DoD won't share with company competitors any improvements that licensees make to the licensed technology and seek to protect via patenting.	3	Strategy & Policies; Processes & Procedures
Strengthen mechanisms to protect private-sector firms' intellectual property if they collaborate with DoD.	3	Processes & Procedures
Establish clearer rules and guidelines on whether royalties may be charged on sales to the U.S. government. Certain DoD labs attempt to get companies to pay royalties on sales of licensed technology to the U.S. government, even though 37 CFR 404 appears to preclude this.	3	Strategy & Policies; Processes & Procedures
Promote the idea of collaborating with DoD on development of dual-use technologies by emphasizing that DoD may be a major customer for the resulting technologies.	3	Processes & Procedures
Make it easier for startup companies and entrepreneurs to present their innovations and technology concepts to DoD.	3	Processes & Procedures
Require DoD labs to acquire and understand Initial Capabilities Documents (ICDs) and Capability Development Documents (CDDs) to inform their decisions about which lab R&D projects to undertake. ICDs document the need for materiel and/or non-materiel approaches to meet a specific capability gap, and CDDs specify the key performance parameters (KPPs) for systems being developed through the Joint Capabilities Integration and Development System (JCIDS) process.	3	Strategy & Policies; Processes & Procedures; Acquisition

Develop "TED-talk-like" YouTube videos on DoD T2, one for an internal DoD audience and one for industry, to promote the importance and benefits of DoD T2.	3	Processes & Procedures
Find ways to overcome venture capital (VC) fund objections to working with DoD through T2 agreements, so that DoD can work with VCs to build innovative startups that can help DoD meet its needs for cutting-edge new technology.	4	Processes & Procedures
Make greater use of the National Security Innovation Network to establish T2 agreements with academic and industry innovators.	4	Processes & Procedures

Tier II: Solutions that will require some additional funding and/or policy changes

Recommendation	Rank	Category
Commission a study involving interviews with all DoD lab ORTAs and supporting legal personnel to determine the staffing and budget levels needed to adequately support DoD's IP protection and T2 functions. This study would be tasked with recommending appropriate quantitative formulas for the resources (budget and personnel) essential for DoD's IP protection and T2 functions—for example, X number of T2 and legal personnel for every X number of S&Es or $XX million in R&D expenditures. Recommendations would consider the different types of R&D and other activities being conducted at the diverse labs and the T2 and commercialization potential of the resulting technologies. For example, labs specializing in R&D on technologies with lower commercialization potential (such as munitions labs) would likely need fewer T2 and supporting legal staff than labs specializing in medical technology. The study should also factor in the size of the current IP portfolio and the lab's potential to generate additional IP; all of the activities that the T2 and legal staff need to undertake, such as training S&Es in IP protection and T2, assisting with invention disclosures, marketing the lab's IP, CRADA, and other T2 opportunities; negotiating and executing T2 agreements; managing the lab's IP and patent portfolio; monitoring and managing the lab's T2 agreements after their execution to ensure that required reports and royalties are submitted to the lab in a timely way; and providing travel funds to enable the T2 and legal staff to attend professional development workshops, etc.	1	Processes & Procedures; Resources

Equip all DoD labs with a standardized, robust T2 management system such as the Defense Technology Transfer Information System (DTTIS) being developed by the Air Force that can facilitate and/or automate IP and T2-related activities--from initial invention disclosures and patent docketing, through technology marketing and T2 agreement generation, to license revenue management and distribution to inventors. In addition to improving efficiency, this system would provide visibility into DoD's innovations and foster effective management of DoD IP at the DoD enterprise or service/major component level.	1	Strategy & Policies; Processes & Procedures; Resources
Establish standardized and streamlined T2 agreements across all DoD components, to make it easier and more cost-effective for both labs and industry to establish agreements.	1	Strategy & Policies; Processes & Procedures
Develop and implement an effective communication strategy to tell the story of how, through technology transfer, the DoD laboratory system benefits the defense mission and American public.	1	Strategy & Policies; Processes & Procedures
Conduct an audit of the DoD laboratory system to determine how many labs with 200 or more full-time equivalent S&Es are not meeting the statutory requirements (per 15 USC 3710) of providing at least one full-time equivalent staff position for its Office of Research and Technology Applications (ORTA).	2	Processes & Procedures; Resources
Develop policies and processes so that DoD labs no longer treat their ORTA as a lab “function” and instead view it as an actual “office” and staff it accordingly. Too many DoD labs have only a part-time T2 manager (commonly called an “ORTA”) to handle that lab’s T2 operations. To be effective, even at smaller labs, an ORTA needs, at a minimum, a T2 manager, a deputy, and three support personnel.	2	Strategy & Policies; Processes & Procedures; Resources
Provide a budget line at each DoD lab against which S&Es can charge their hours spent drafting invention disclosures and participating in IP protection and T2 activities. FLEX-4 funds (formerly Section 219 funds) could feasibly be used for this purpose.	2	Resources; Processes & Procedures
Provide more funding for S&Es to attend important technology conferences to facilitate contacts and collaborations with industry. FLEX-4 funds (formerly Section 219 funds) could be feasibly used for this purpose.	2	Resources; Processes & Procedures

Make it easier for DoD acquisition programs to fund prototype and other advanced technology development (6.3 funds) and advanced component development and prototypes (6.4 funds) in DoD labs.	2	Processes & Procedures; Resources; Acquisition
Develop policies and processes to enable the acquisition community to be more proactive in communicating with DoD end users, to determine their technology needs and technology gaps, and to work closely with DoD labs to develop technology to address those gaps.	2	Strategy & Policies Processes & Procedures; Acquisition
Free DoD patent attorneys from lower-value administrative tasks, so they can focus on IP protection.	2	Processes & Procedures
Harmonize R&D goals across the DoD laboratory enterprise and ensure that R&D being conducted in DoD labs is strongly aligned with DoD mission needs.	2	Strategy & Policies; Processes & Procedures
Establish policies and mechanisms to prioritize DoD T2 activities that support the defense mission, to ensure greater support for T2 throughout DoD, from S&Es to the top echelons of the Pentagon.	2	Strategy & Policies; Processes & Procedures
Establish policies and mechanisms to enable DoD labs to get feedback from end-users in the U.S. military on technology needs and requirements.	2	Strategy & Policies; Processes & Procedures
Develop more inclusionary policies to engage women and minority S&Es in IP development, protection, T2, and technology transition.	3	Strategy & Policies
Locate Chief Scientists at acquisition product centers who would act as advisors and interact with DoD labs to identify, vet, and pull in technology, and who would help bridge the gap between the labs and acquisition programs. These Chief Scientists would be high-level, experienced, former lab S&Es who are experts in specific technology fields and have a good personal network of contacts in the S&E community.	3	Strategy & Policies; Processes & Procedures; Acquisition
DoD labs should make greater use of local partnership intermediaries to function as objective, third-party facilitators of CRADAs, EPAs, and test service agreements with companies proximate to the labs.	3	Strategy & Policies; Processes & Procedures
Change policies so DoD labs and acquisition programs focus less on short-term R&D goals and metrics, such as how quickly funds are	3	Strategy & Policies; Metrics; Resources;

obligated and spent, and more on longer-term goals and metrics to achieve substantial impacts on the defense mission.		Acquisition
Establish policies and procedures to change DoD's patenting culture from protecting IP for defensive purposes to protecting IP to serve strategic RDT&E goals.	3	Strategy & Policies
Establish policies that give DOD T2 offices greater authority to ensure that S&Es cooperate with IP protection and T2.	3	Strategy & Policies
Establish policies and mechanisms that encourage coordination on IP protection between different DoD labs and programs, to improve greater efficiencies and cost savings.	3	Strategy & Policies; Processes & Procedures
Establish policies and mechanisms to strengthen communications between S&Es, industry, and the acquisition community to facilitate technology transition. For example, acquisition program offices should be consulted prior to launching of new lab R&D projects, to seek their input and to help these acquisition programs plan to transition the technology to a program of record where warranted.	3	Strategy & Policies; Processes & Procedures; Acquisition
Establish policy changes and mechanisms so that DoD uses R&D goals to design R&D projects, rather than putting design goals around existing R&D projects.	3	Strategy & Policies; Processes & Procedures
Establish mechanisms to incentivize venture capital firms to support innovative startup companies that develop defense-related technologies.	4	Processes & Procedures
Delegate authority to establish CRADAs to senior acquisition managers (PEOs or PMs) so that they can use CRADAs to evaluate promising private-sector technology or engage with industry for further (low- or no-cost-to-DoD) development of new technologies to meet critical DoD technology needs. This change would require addressing acquisition issues such as competition, fairness, and sole sourcing. However, having the authority to establish CRADAs would enable DoD acquisition programs to field technologies more rapidly and would also lead to greater acceptance of T2 mechanisms within the acquisition community.	4	Strategy & Policies; Processes & Procedures; Acquisition
Change policies to allow more remote work, to help labs recruit and hire more legal staff for IP protection and support of T2.	4	Strategy & Policies

Tier III: Solutions that require substantial additional funding and policy changes

Recommendation	Rank	Category
Change patent filing and maintenance fees for micro and small entity licensees of U.S. government technology so they are not stuck paying the large entity fees passed through to them because the government is the patent holder. They should pay lower fees that are pegged to their actual corporate size.	1	Strategy & Policies; Processes & Procedures
Revise policies and procedures so that DoD labs, acquisition programs, and end users are synchronized and integrated into a unified, end-to-end strategic plan focused on the defense mission, with an accompanying investment roadmap for technology transfer and transition. This strategic plan and roadmap need to establish a consistent standard to determine transition readiness, to eliminate the current "valley of death" that occurs when DoD labs consider their R&D efforts on a technology to be completed, but acquisition programs think the technology is not yet ready for transition. The roadmap also needs to establish clearly defined onramps to allow lab technologies to enter into acquisition programs with well-understood rules regarding what is needed to enter these onramps and where they fit in the overall acquisition process.	1	Strategy & Policies; Acquisition
Provide adequate staffing and funding to the DoD lab T2 offices so they can successfully undertake the T2 function for their labs and enable T2 to achieve its potential. Adequate staffing and funding would allow ORTAs to be proactive rather than merely reactive. It would enable T2 personnel to adequately educate lab S&Es and lab leaders in the importance of IP protection and T2 to the defense mission and also what can be accomplished with the various T2 mechanisms; adequately train S&Es in how to draft invention disclosures and engage with the IP attorneys and T2 office; proactively interact with the lab's research teams to learn of new inventions and stay informed on the progress of major research projects; market the lab's CRADA, licensing, and other T2 opportunities to industry; and follow up on leads to help establish T2 agreements. It would also enable them to follow up with DoD's T2 partners, after the license agreements are signed and the CRADA projects are completed, to learn of the outcomes of those agreements, to ensure that license royalties are being paid, and to inform the T2 partners of possible DoD programs to assist them in further development of the technologies and transition to DoD operational	1	Strategy & Policies; Resources; Processes & Procedures

use. Finally, it would give them the time and resources to attend training seminars and conferences to stay up-to-date and advance as T2 professionals.		
Provide adequate staffing and funding to the legal offices supporting the IP protection and T2 function so they can be successful in their jobs; adequately protect DoD's inventions and other IP; assist in training S&Es in drafting invention disclosures, providing assistance when needed; have the time to review license applications and T2 agreements for legal sufficiency and adherence to the law; and spend the time needed to draft high-quality patent applications and achieve high-quality issued patents. As appropriate, to achieve cost-effectiveness, engage paralegals and contract IP attorneys and patent agents to assist and to help manage surges in the workflow.	1	Strategy & Policies; Resources; Processes & Procedures
Consider establishing a "technology pull" process for the entire DoD R&D, T2, and technology transition system, starting with DoD requirements, to effectively integrate all these processes and increase their impact on the defense mission.	2	Processes & Procedures; Acquisition
Centralize the T2 budget for each service or major component within that entity's T2 program office, so that DoD lab T2 offices receive their funding directly from that office, to give all ORTAs the sustained, reliable support they need to be effective. Currently, these T2 offices receive funding from lab director offices, which is problematic because leaders frequently change, and many lab leaders know very little about T2 when they assume their posts.	2	Strategy & Policies; Resources
Update laws regarding government-developed software so that the government interest can be more easily protected. For example, U.S. government entities currently cannot obtain copyrights on new software programs, which makes it difficult to protect the government's interest in these programs.	2	Strategy & Policies
Allocate a small percentage of the DoD laboratory system R&D budget (akin to the SBIR program tax), such as a 1.5% of DoD's basic, applied, and advanced technology development research funding, to adequately fund the DoD IP protection and technology transfer system.	2	Strategy & Policies; Resources

Change patent filing fees for U.S. government agencies so that they pay low or no patent filing fees. The current patent filing fee schedule for U.S. patents is broken down into three categories: micro entity, small entity, and large entity. The government pays large entity fees, which is triple what a micro entity pays. The U.S. government should create a category for itself that greatly reduces the cost of filing patents. This new category should also greatly lower patent maintenance fees, which can be exorbitant for a command with a number of patents. The U.S. government (USPTO) should not be charging itself to protect its own IP for the benefit of the U.S. public.	2	Strategy & Policies; Processes & Procedures
Establish a longer-term view of technology development to counter the prevailing emphasis on short-term problem solving. This will require making more R&D funding available over the longer term, to sustain R&D projects and counter the prevailing urgency to expend funds as quickly as possible.	3	Strategy & Policies; Resources
Establish policies and procedures to require DoD labs having R&D programs in technology areas shared with other DoD labs to coordinate their R&D, IP protection, and T2 efforts to achieve cost savings and maximum their impacts.	3	Strategy & Policies; Processes & Procedures
Review existing T2 authorities and change policy where appropriate to enable the DoD T2 to have a greater impact on the defense mission.	3	Strategy & Policies
Change policies and funding allocations to orient R&D in the DoD lab system primarily on applied research as opposed to basic research. Focusing on specialized applied research, drawing on existing basic technologies, would enable more rapid fielding of new defense or dual-use products and lead to increased T2 engagements with industry and increased acquisition of DoD lab technologies. In many technology fields, basic research in academia and industry has a competitive advantage over that being undertaken in DoD labs. In only a few specific technology areas, such as munitions or trauma care, is basic research by DoD labs essential because this research is not being adequately undertaken by others.	4	Strategy & Policies; Resources; Acquisition

Activities

Tier I: Low-to-no-cost solutions that can be most readily implemented

Recommendation	Rank	Category
Establish metrics to track how many S&Es have received training in IP protection and T2 and how often this training has been provided.	1	Processes & Procedures; Metrics; Education & Training
Facilitate the invention disclosure process by making it an electronic, paperless process and assisting S&Es with drafting of these disclosures.	1	Processes & Procedures
Require S&E invention disclosures to be submitted to both the lab's IP counsel and the ORTA. In some labs, ORTAs have complained that they are out of the loop regarding new invention disclosures, which hinders their effectiveness.	1	Strategy & Policies; Processes & Procedures
Encourage DoD lab leaders to create a lab culture in which S&Es are consistently motivated to disclose all their inventions, and in which it is recognized by all lab personnel that patenting is an essential way to demonstrate the value and productivity of individual S&Es, specific research programs, and the lab itself.	1	Strategy & Policies; Processes & Procedures
Encourage DoD labs to use CRADAs strategically to develop dual uses of patented lab technology, establishing metrics for the number of these dual-use CRADAs and marketing CRADA opportunities with the lab accordingly.	1	Strategy & Policies; Processes & Procedures; Metrics
Simplify and make the T2 process across the DoD lab system less bureaucratic, to enable T2 agreements to be developed and signed more rapidly and to encourage greater participation of industry. Potential ways to accelerate the T2 process include delegating signature authority to the lowest level possible; enabling online applications, negotiations, and signing of agreements; and clearly identifying the non-negotiable clauses in the license agreements and CRADAs, to save all involved parties both time and money.	1	Processes & Procedures
Mandate that all DoD license agreements require licensees to disclose (in their annual royalty reports) all sales to the U.S. government (even though these sales are not royalty-bearing) as well	1	Strategy & Policies; Processes & Procedures;

as all sales to defense contractors, so DoD labs will know of transition to DoD operational use. This information should include as much specificity as possible as to which DoD components are procuring the technology and how it is being used.		Acquisition
Establish metrics to track the timely provision of required reports and royalty payments to labs from T2 agreements after their execution.	1	Policies & Procedures; Metrics
Provide regularly scheduled, mandatory, hands-on training to S&Es in how to draft invention disclosures and how to engage with their lab's IP attorneys and T2 office.	2	Education & Training
Establish metrics to track the number of S&Es assisted with drafting invention disclosures.	2	Processes & Procedures; Metrics
Provide incentives at all labs for S&Es to fully engage in IP protection, T2, and technology transition of new inventions from their labs to DoD operational use. This could include small cash awards for filing invention disclosures and/or being listed as an inventor on an issued patent; time-off awards, which are especially valued by younger S&Es who don't get much annual leave; presenting plaques or trophies for being listed as an inventor on a patent; a "Lab Inventor of the Year" or "Invention of the Year" award; and awards and public recognition for participating in a CRADA or license agreement that has an significant impact on the defense mission.	2	Strategy & Policies; Processes & Procedures
Establish an annual OSD award program to recognize S&Es for meritorious contributions to T2, comparable to the George Lindsteadt awards for ORTAs, to raise the visibility of T2 in the S&E community, incentivize participation in T2, and effect cultural change. For example, one award could be for S&Es who are prolific generators of invention disclosures and issued patents; another for outstanding successes in generating new dual-use technology in collaboration with industry; and a third for S&Es who have patented or CRADA-related inventions that have successfully transitioned to DoD acquisition programs and have had a significant impact on the defense mission.	2	Strategy & Policies; Processes & Procedures
Enable and motivate T2 personnel to regularly interact with S&Es to brief them on IP protection and T2 and to learn of new technologies that the S&Es are developing.	2	Processes & Procedures

Establish metrics to track interactions of T2 personnel with S&Es to brief them on IP protection and T2 and to learn of new technologies the S&Es are developing.	2	Processes & Procedures; Metrics
Establish a system at all DoD labs to enable the T2 office to remain up to date on patent prosecution actions, so they can pursue T2 opportunities on the subject inventions in a timely way.	2	Strategy & Policies; Processes & Procedures
Establish a standard DoD-wide process whereby S&Es developing publications or public presentations are required to attest that the publications or presentations either do not disclose any inventions (for example, through a check box on the publication clearance form) or have already been disclosed to the lab's ORTA or legal counsel using the approved invention disclosure form.	2	Strategy & Policies; Processes & Procedures
Establish DoD-wide guidelines on pursuing foreign patent protection, such as recommending that DoD labs not pursue foreign patent protection unless the DoD invention is considered to be of very high commercial value (e.g., an important medical invention) or of interest to major corporations with global marketplaces. In cases where foreign patent protection is considered warranted, DoD labs need to submit an international patent application under the Patent Cooperation Treaty (PCT) and let licensees pursue country-specific national-stage patent protection at their own expense. PCTs are much less expensive than national-stage filings, so this approach will both save money and allow the licensees to select the countries of interest for patent protection. According to executives of the major corporations interviewed, their companies greatly prefer to license the technology at either the U.S. patent application or PCT application stage, so they can have complete flexibility in deciding where to pursue foreign patent coverage.	2	Strategy & Policies; Processes & Procedures
Provide incentives at all labs for lab leaders to fully engage in IP protection, T2, and technology transition of new inventions from their labs to DoD operational use. This could include "Lab Leader of the Year" awards and national recognition for lab technologies transitioned via T2 that have a significant impact on the defense mission.	2	Strategy & Policies; Processes & Procedures
Encourage lab T2 personnel to use opportunities to visit S&Es in their research facilities (for example, during scheduled lab tours), so they remain informed about their lab's R&D projects without creating an extra burden on the S&Es.	2	Processes & Procedures

Encourage DoD labs to evolve from their current reactive, stand-alone approach to T2 agreements and strategically plan how they can best commercialize and transition their new inventions using combinations of CRADAs and license agreements.	2	Strategy & Policies; Processes & Procedures
Encourage DoD labs to promote CRADAs with DoD licensees of dual-use lab technologies to assist these companies in final development and productization, so products based on these technologies can be procured by DoD to support the defense mission.	2	Strategy & Policies; Processes & Procedures
Encourage increased use of T2 mechanisms to solve near-term technology issues within the DoD mission, to complement the main focus on addressing long-term technology needs. There are lingering problems that T2 could readily solve for the Warfighter.	2	Strategy & Policies; Processes & Procedures
Establish better outreach to small, innovative, non-traditional DoD T2 partners, emphasizing the benefits to companies from engaging in T2 with DoD.	2	Strategy & Policies; Processes & Procedures
Encourage labs to experiment with creative ways to speed up negotiation of T2 agreements, such as by using online meeting platforms.	2	Processes & Procedures
Improve the language in DoD license agreements and CRADAs to make it more explicit that DoD won't share company IP with competitors.	2	Strategy & Policies; Processes & Procedures
Encourage use of shorter and simpler T2 mechanisms where appropriate, such as by using material transfer agreements or limited purpose (LP) CRADAs instead of CRADAs to transfer material samples and information between DoD labs and industry. This would accelerate licensing of DoD lab technologies and enable DoD labs to more rapidly screen and evaluate industry technologies for possible DoD applications.	2	Strategy & Policies; Processes & Procedures
Encourage DoD labs to establish license agreements that are "win-wins" for both the lab and the licensee, to help ensure that the technology is developed into a product that benefits the defense mission and/or U.S. economy.	2	Strategy & Policies; Processes & Procedures
DoD labs should offer in their license templates to give licensees of DoD technologies a limited number of hours (e.g., up to 10 hours) to consult the DoD inventors about their inventions, to assist in reducing these inventions to practical application. Along with this, DoD should	2	Strategy & Policies; Processes & Procedures

provide centralized funding for this assistance. At present, many labs require the establishment of CRADAs for any post-licensing assistance, even when only a limited discussion between the DoD inventors and licensees is necessary. This wastes both time and resources for all involved parties and/or discourages licensees from seeking vital assistance from the DoD inventors.		
Encourage DoD labs to provide the complete data package to companies for the inventions that they license, without requiring a separate CRADA for this information, to assist these companies in final development and commercialization of the licensed invention.	2	Processes & Procedures
Develop clear instructions for finance officers throughout the DoD lab system on how to handle money received from industry under CRADAs, to overcome the problems that a significant number of labs (especially smaller labs that do not establish many CRADAs) encounter in this regard.	2	Processes & Procedures
Clearly define the differences between technology transfer and technology transition, to remove widespread confusion about these two related but different processes.	2	Processes & Procedures; Acquisition
Encourage DoD labs to get endorsements on their S&T/R&D efforts from the acquisition programs. This used to happen regularly but is dropping off, leading to misalignments between DoD lab R&D and DoD end user requirements.	2	Processes & Procedures; Acquisition
Establish effective processes to enable early collaboration between DoD labs, the acquisition community, and end users so that new technology can be modified as needed while it is still being developed.	2	Processes & Procedures; Acquisition
Train relevant DoD lab staff on how to prepare the documents and information needed to support technology transition, such as Technology Transition Agreements (TTAs).	2	Education & Training; Acquisition
Minimize the number of signatures necessary to establish TTAs to accelerate the process; for example, limit to capabilities lead in lab (usually division chief), contracts manager (money person), and acquisition program managers.	2	Strategy & Policies; Processes & Procedures
Establish a mechanism for DoD T2 offices to get regular (e.g., monthly) updates on what other DoD T2 offices are achieving and the best practices they are employing.	3	Processes & Procedures; Education & Training

Institute monthly training for the DoD T2 community, using Teams or Zoom, and drawing on experienced T2 and legal personnel who are experts in specialized areas of T2 and IP protection.	3	Education & Training
Establish metrics to benchmark and measure the number of different lab S&Es engaging in the IP protection and T2 process over time at the lab, component, and DoD laboratory system levels.	3	Processes & Procedures; Metrics
Train lab S&Es to pitch their technologies in a "Shark Tank" way to the acquisition community and establish annual events at which these technology pitches occur in order to inform the acquisition community of promising new lab technologies that could meet acquisition program needs.	3	Education & Training; Processes & Procedures; Acquisition
Require and standardize use of IEBs or IECs at all DoD labs in order to evaluate inventions disclosed by S&Es prior to seeking patent protection and provide guidelines for best practices in the composition and processes for these IEBs or IECs.	3	Strategy & Policies; Processes & Procedures
Encourage IEBs or IECs to consider whether DoD inventions have either commercial or dual-use potential; if not, then perhaps the DoD lab should not pursue patent protection on these inventions.	3	Strategy & Policies; Processes & Procedures
Encourage all DoD labs to more frequently use provisional rather than standard patent applications to allow greater time for patenting decisions and to determine potential market interest in licensing these inventions or further developing them under CRADAs. This use of provisional patent applications is widely considered a best practice in university licensing in the United States.	3	Strategy & Policies; Processes & Procedures
Allow attorneys for DoD licensees to draft patent applications for DoD attorney review and submittal in cases where this approach is justified by specific circumstances, such as when the licensing company has patent attorneys specialized in the company's technology area or there is a backlog in the lab's patent application pipeline.	3	Strategy & Policies; Processes & Procedures
Establish metrics to track the number of companies contacted to promote licensing, CRADA, and other T2 opportunities with the lab.	3	Policies & Procedures; Metrics
In their marketing efforts, DoD labs should emphasize dual-use applications where applicable, and ensure companies understand that DoD represents a large customer base for many dual-use products.	3	Strategy & Policies; Processes & Procedures

Experiment with ways to make the business communities surrounding DoD labs much more aware of partnering opportunities with the lab through T2 mechanisms, perhaps with more prominent lab technology days.	3	Processes & Procedures
Require potential licensees to include in their commercialization plans if or how they intend to develop and commercialize the licensed technology for sales to the U.S. military. If there are other companies competing to license a given technology, this information should or could be an important or decisive factor.	3	Strategy & Policies; Processes & Procedures
Obtain greater input from ORTAs when attempting to change laws and policies affecting the DoD T2 system.	3	Strategy & Policies
Ensure that CRADAs are receiving adequate technical and administrative oversight while they are active.	3	Processes & Procedures
Require all S&Es to route all draft publications through the lab's Invention Evaluation Board or Committee (IEB or IEC) for quick review for potentially patentable IP.	4	Strategy & Policies; Processes & Procedures
Establish processes to expedite facility and personnel clearances for small companies and academic partners so these outside parties can work more effectively with DoD S&Es on CRADAs and classified research projects.	4	Processes & Procedures
Encourage or require DoD acquisition programs to pay for patenting in the DoD labs, so they will more greatly value DoD IP and have a greater stake in new technology development in DoD labs and be more inclined to source new technology from DoD labs.	4	Processes & Procedures; Resources; Acquisition

Tier II: Solutions that will require some additional funding and/or policy changes

Recommendation	Rank	Category
Establish a centralized database to track all DoD published patent applications and issued patents. Require DoD labs and acquisition programs to consult this database and determine what DoD is already developing in its lab system before initiating new R&D or acquisition projects, to help avoid unnecessary, time-consuming, and costly "reinventing of the wheel" and to assure that the DOD is not acquiring goods at a premium that are covered by intellectual property in which the DOD has an ownership interest. Note: This database will only reveal IP produced from the fraction of R&D that resulted in disclosed inventions and should not be viewed as a comprehensive database of R&D projects.	2	Strategy & Policies; Processes & Procedures; Acquisition
Establish and regularly update a centralized database of all DoD technologies that have high potential to meet DoD mission needs and that have either been licensed to industry or co-developed under a CRADA. Encourage DoD acquisition programs to consult this database to identify technologies that could meet their technology needs.	2	Strategy & Policies; Processes & Procedures; Acquisition
Establish policies and mechanisms to enable DoD labs and acquisition programs to align funding and activities to better address DoD's technology sustainment and maintenance needs.	2	Strategy & Policies; Processes & Procedures; Resources; Acquisition
Offer licensees of DoD technologies that have dual-use potential a reduction in the royalty rate (for example, a 25% reduction) if they achieve certain thresholds of or percentages of sales to the U.S. military (either directly or through a defense contractor) to incentivize them to commercialize the technology for DoD use. The threshold or percentage of sales necessary to trigger this rate reduction would also be mutually agreed upon during the license negotiation and would depend upon the company's technology commercialization plan and the nature of the technology.	2	Strategy & Policies; Processes & Procedures
Establish "customer satisfaction surveys" at all DoD labs to determine S&E satisfaction with the lab's legal and T2 office to improve service and generate more invention disclosures and increased participation in IP protection and T2 projects.	2	Processes & Procedures

Regularly assess the private sector's experience establishing a license or CRADA with DoD using a short "customer satisfaction" survey following the execution of agreements. These surveys could be conducted by the service T2 program offices or by PIAs to maintain the confidentiality of the responses.	2	Processes & Procedures
Establish a DoD lab system-wide contract with a patent firm to draft patent applications, which labs could use during surges in invention disclosures or when their IP counsel has a backlog and is unable to process invention disclosures in a timely way.	3	Strategy & Policies; Processes & Procedures
Change policies as necessary to allow cross-organization funding for S&Es with particular skills. Certain S&Es within the DoD lab system have unique high-value expertise in certain technical areas and this expertise is often in demand by multiple DoD organizations. Mechanisms need to be created to enable different organizations to fund the time and expenses of these experts.	3	Strategy & Policies; Resources; Processes & Procedures
Establish policy to fix the following problem: S&Es funded through acquisition programs are asked to assist original equipment manufacturers (OEMs) on developing the lab technology and are asked not to file invention disclosures on inventions that occur through acquisition funding.	3	Strategy & Policies; Acquisition
Explore ways to use artificial intelligence (AI) algorithms to find strong T2 partners for specific CRADA and licensing opportunities, to help commercialize and transition lab inventions.	3	Processes & Procedures
Establish DARPA-like challenges with accompanying cash prizes to enable businesses (especially small technology firms) to access unique DoD lab facilities to develop new technologies that meet critical defense mission needs. This would require a service or DoD-wide funding program. Labs could compete for funding to sponsor these challenges, which would be specific to the lab and consistent with its mission.	3	Processes & Procedures; Resources
Require DoD acquisition programs to pay for S&E time spent on CRADAs involving technologies in these acquisition programs.	3	Processes & Procedures; Acquisition; Resources

Tier III: Solutions that require substantial additional funding and policy changes

Recommendation	Rank	Category
Centralize management of DoD license agreements at the DoD Service or component level to improve monitoring of whether these agreements are meeting their milestones, tracking of commercialization of the licensed inventions, timely payment of royalties, and insight into whether transition to DoD operational use is occurring.	2	Strategy & Policies; Processes & Procedures
Establish programs to financially incentivize companies to partner with DoD on development of new technologies having both military and commercial applications, such as the former Dual Use Science and Technology (DU S&T) Program.	3	Processes & Procedures
Change the PIA statute to explicitly allow spin-in T2 activities such as CRADAs as opposed to current focus on spin-out T2, so partnership intermediaries, especially the local PIAs, can be more effective and helpful.	4	Strategy & Policies
Change DoD policy to delegate trademark license agreement signature authority to the lab and enable trademark revenues to go directly to the lab.	4	Strategy & Policies

Outputs

Tier I: Low-to-no-cost solutions that can be most readily implemented

Recommendation	Rank	Category
Establish metrics that benchmark and measure the numbers of invention disclosures and patent applications over time at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
Establish metrics that benchmark and track the numbers of different types of T2 agreements over time at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
Establish metrics to benchmark and measure the percentage of DoD patents that are licensed by industry over time at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
Establish metrics for tracking the execution time to establish CRADAs and license agreements at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
In labs where TTAs are used, establish metrics to benchmark and measure the number of TTAs that are established with acquisition programs over time, and encourage all labs to use TTAs to promote acquisition of DoD lab technologies.	1	Processes & Procedures; Metrics; Acquisition
Ensure that lab technologies have IP protection as well as data rights to prepare them for transition.	1	Processes & Procedures
Provide in-depth training to key DoD lab personnel so they understand how to prepare the necessary documentation to support transition of new technologies to acquisition programs.	1	Education & Training; Acquisition
Develop a standard rapid contracting mechanism to enable DoD acquisition programs to procure small production quantities of DoD lab-developed technologies for evaluation in the field, with the option to expand purchases and transition these technologies if they perform well.	1	Strategy & Policies; Processes & Procedures; Acquisition

Establish metrics to quantify and track the amount of R&D funds expended per invention disclosure at the lab, component, and DoD laboratory system levels.	2	Processes & Procedures; Metrics; Resources
Establish metrics that benchmark and measure the ratio of the number of invention disclosures to the numbers of PLAs over time at the lab, component, and DoD laboratory system levels.	2	Processes & Procedures; Metrics
Establish metrics for licensing of dual-use DoD lab technologies that could have a significant impact on the defense mission.	2	Processes & Procedures; Metrics
Require DoD labs to consider the manufacturability and manufacturing readiness level (MRL) of technologies that they are developing. This is extremely important to acquisition program managers and the OEMs with which they typically work to develop products for DoD acquisition.	2	Strategy & Policies; Processes & Procedures; Acquisition
Establish metrics that measure the number of patent applications per DoD's total R&D expenditures and/or the size of the S&E workforce, benchmarking these metrics against the comparables in other peer federal agencies, such as DOE and NASA.	3	Processes & Procedures; Metrics
Establish metrics that measure the number of patent license agreements (PLAs) and other license agreements appropriate for DoD's total R&D expenditures and/or patent portfolio, benchmarking this metric against the number of license agreements per intramural R&D expenditures or patent portfolio size in peer federal agencies, such as DOE and NASA.	3	Processes & Procedures; Metrics
Determine if software programs or systems being developed by DoD labs have open architecture or if they need additional protections to prepare them for transition.	3	Processes & Procedures
Encourage all DoD components to use the Middle Tier of Acquisition when appropriate (such as for medical product development) to enable rapid prototyping and fielding of critically needed, affordable, and cost-effective products and capabilities.	3	Processes & Procedures; Acquisition
Consider using export readiness assessments to create export readiness levels (ERLs) for DoD lab technologies being considered for transition. The exportability readiness of defense products is an implied Better Buying Power 2.0 imperative, and being able to	3	Strategy & Policies; Processes & Procedures; Acquisition

undertake foreign military sales (FMS) to U.S. allies is an important consideration for acquisition program managers.		

Tier II: Solutions that will require some additional funding and/or policy changes

Recommendation	Rank	Category
Incentivize all DoD lab leaders to try to transition their lab's new technologies to the Warfighter by making transitioning lab technologies to the Warfighter a rated element in all lab leader performance reviews and adding metrics for this element.	1	Processes & Procedures; Acquisition; Metrics
Establish mechanisms to foster strong communications between DoD labs and acquisition programs about promising DoD lab technologies in order to lay a foundation for transitioning those technologies to a Program Office that handles acquisition of those kinds of technologies.	1	Processes & Procedures; Acquisition
Commission a study to identify ways to make it easier and less risky for acquisition programs to engage with DoD labs on technology transition. Currently, the acquisition process is too rigid and inflexible: Technology needs to be developed on schedule, transition funds need to be available on schedule, and contracts need to be awarded on schedule. It is much less risky for DoD program managers to contract with defense contractors for new technology than to engage with DoD labs. Because it is hard to schedule innovative breakthroughs, it is impossible to get funding through the normal POM process. Funding needs to be available outside the normal cycle that is distributed in the year of execution specifically for the technology transfer.	1	Strategy & Policies; Acquisition; Resources
Establish clearly understandable processes to promote transition of promising new DoD lab technologies to acquisition programs via the T2 pathway, using streamlined acquisition authorizations (DoDI 5000.80 and 5000.81) where justified.	1	Strategy & Policies; Processes & Procedures; Acquisition
Establish a mechanism to track whether DoD labs pay the 2nd and 3rd patent maintenance fees, and determine why or why not, to inform patenting policy. For example, if a common reason is lack of funding to pay these fees and keep the patents active, then that should influence DoD budgeting decisions. On the other hand, if common reasons include the desire to obtain defensive patents or lack of industry interest in licensing these inventions, then those factors should perhaps influence patenting policy.	2	Strategy & Policies; Processes & Procedures; Resources

Commission a study to identify all the barriers preventing DoD lab technologies from transitioning to DoD acquisition programs, and develop recommendations on ways to overcome these barriers.	2	Processes & Procedures; Acquisition
Develop pilot programs focused on transitioning DoD lab technologies into acquisition programs via the T2 pathway.	2	Processes & Procedures; Acquisition
Conduct follow-up analyses on license agreements to determine which types of DoD technologies were licensed successfully to see if there are any lessons to be learned. For example, this analysis would consider the technology sector (medical, materials, sensors, electronics, etc.) and whether the technology had potential dual-use or military applications for which DoD could be a customer.	2	Processes & Procedures
Conduct follow-up analyses on T2 agreements to determine how many DoD S&Es are repeat versus first-time disclosers of inventions; how many DoD S&Es are repeat versus first-time participants in T2 agreements; how many CRADA and license partners are repeat versus first-time customers; and whether the T2 partners are located near the lab versus elsewhere.	2	Processes & Procedures; Metrics
Establish DoD lab-wide processes to enable DoD labs to better track and "police" their T2 agreements after they are signed in order to monitor progress, ensure that milestones are being met, see if CRADA-subject inventions are being reported, and learn of ultimate outcomes and impacts on the defense mission and national economy.	2	Processes & Procedures; Metrics
Develop a pilot program to link together T2 and SBIR activities to increase the likelihood of DoD technology transition--for example, by sponsoring SBIR topics that involve further development of DoD lab-developed technology.	2	Processes & Procedures; Acquisition
Develop policies and mechanisms to expand the use of TTAs between DoD labs and DoD acquisition programs and to establish an effective pathway for lab technology to transition to DoD operational use. TTAs should include a description of the technology project, the key personnel and programs associated with the project, the specific performance characteristics and cost parameters of the technology required for transition to occur, acquisition program funding available for transition, and when that funding will be available. In addition, policy changes are needed to lengthen the terms of TTAs when the technology development process requires this.	2	Strategy & Policies; Processes & Procedures; Acquisition; Resources

Develop regular processes to make the acquisition community aware of critically needed technology that has been licensed from the lab, or co-developed with the lab, that is being further developed and productized by private industry.	2	Processes & Procedures; Acquisition
Develop policies and mechanisms to incentivize defense contractors to subcontract with DoD T2 partners that have developed new defense-related products through license agreements or CRADAs.	2	Strategy & Policies; Processes & Procedures; Acquisition
Conduct follow-up analyses to see what DoD inventors do with their inventions post-retirement. For example: Do they continue with T2 engagements? Do they start a company to commercialize the technology? Do they join a company that licensed the technology or consult with that company?	3	Processes & Procedures
Develop and start using a "transition readiness level" rather than the currently used "technology readiness level" when evaluating DoD lab technologies for acquisition.	3	Processes & Procedures; Acquisition
Establish a process by which DoD PMs and PEOs engage with DoD licensees and CRADA partners at an early stage, brief them on military needs and requirements, provide interactions with end users, and provide funding opportunities for meeting DoD needs and requirements.	3	Processes & Procedures; Acquisition
Audit the inventions coming out of R&D contracts, such as SBIR contracts, to learn of promising new technologies that are good candidates for spin-in to DoD acquisition programs.	3	Processes & Procedures; Acquisition
Encourage and facilitate interactions between SBIR companies and acquisition programs to achieve greater spin-in of innovative new DoD SBIR-funded technologies to acquisition programs.	3	Processes & Procedures; Acquisition
Develop mechanisms to accelerate the acquisition timeline of programs such as the Capital Investment Program (CIP).	3	Processes & Procedures; Acquisition
Change the system so acquisition programs don't have to expend their funding so rapidly, which incentivizes them to work with industry rather than DoD labs.	3	Processes & Procedures; Acquisition; Resources

Change the system so that FAR-based RFPs can specify a specific DoD lab-developed technology when one is available. Currently, FAR-based RFPs rarely specify a specific technology solution, which encourages vendors to use their own proprietary technologies, rather than lab technologies.	3	Strategy & Policies; Processes & Procedures; Acquisition; Resources

Tier III: Solutions that require substantial additional funding and policy changes

Recommendation	Rank	Category
Establish policies and programs, perhaps at the Pentagon level, to provide funding to DoD labs specifically to enable labs to advance the technology readiness level (TRL) of promising new DoD lab technologies, to get them through the "valley of death" that occurs at the end of many lab R&D projects and to prepare these technologies for technology transfer and transition. One idea is to establish a funding program at the Pentagon level to which acquisition program managers can apply to obtain funding for prototyping and TRL advancement prior to the execution year. Another idea is for a program to provide timely funding to help transition unexpected lab technology breakthroughs.	2	Strategy & Policies; Resources; Processes & Procedures; Acquisition
Use Manufacturing Technology (ManTech) funds to advance DoD lab technologies to a minimum of manufacturing readiness level (MRL) 6 and ensure that there are sufficient ManTech funds across the DoD lab system for this purpose.	2	Strategy & Policies; Resources; Acquisition
Consider establishing a Transition Directorate in each service to focus on transitioning DoD lab technology to acquisition programs via the T2 pathway.	2	Strategy & Policies; Acquisition
Establish end-user representatives in all DoD labs who are charged with supporting transition of lab technologies to acquisition programs.	2	Strategy & Policies; Processes & Procedures; Acquisition
Create many more positions for "advanced technology integrators" to help acquisition programs identify, evaluate, and acquire promising new DoD lab technologies that can benefit the defense mission.	2	Resources; Strategy & Policies; Processes & Procedures; Acquisition
Provide increased funding and staff to acquisition programs to handle the extra work of transitioning DoD lab technologies to DoD operational use.	2	Resources; Strategy & Policies; Acquisition
Encourage the DoD acquisition system to give priority to acquiring DoD lab-developed technology from companies that have either licensed DoD lab technologies or co-developed new technologies with DoD labs to reap the full benefits of the DoD laboratory enterprise and help reduce procurement costs for new technology.	2	Strategy & Policies; Processes & Procedures; Acquisition

Change the FAR and associated policies so DoD can use sole-source mechanisms to procure new DoD lab-developed technologies that have been transferred to industry through license agreements and CRADAs for final development and manufacture, in the same way that DoD acquisition programs can now sole source DoD SBIR-developed technologies.	2	Strategy & Policies; Processes & Procedures; Acquisition
Commission a study to investigate the ways that the FAR and the POM process discourage transition of new technology from DoD labs and to identify ways to overcome these current barriers.	3	Strategy & Policies; Processes & Procedures; Acquisition
Increase funding to enable S&Es to participate more fully in transition of new lab-developed technology to acquisition programs and DoD operational use.	3	Resources; Strategy & Policies; Acquisition

Intermediate Outcomes

Tier I: Low-to-no-cost solutions that can be most readily implemented

Recommendation	Rank	Category
Establish metrics that benchmark and measure the numbers of issued patents over time at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
Establish metrics that benchmark and measure the ratio of the number of invention disclosures to the number of issued patents over time at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
Establish metrics that benchmark and measure the patent allowance rate at the lab, component, and DoD laboratory system levels in order to quantify the number of patent applications that become issued patents over time.	1	Processes & Procedures; Metrics
Establish metrics to track the number of patents that result from license agreements and CRADAs at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
Establish metrics for the acquisition community to track whether the technologies being acquired originated in the DoD lab system and whether the T2 process was involved. These metrics should align with PM metrics on effective use of S&T/R&D funds as well as lifecycle costs of new technologies being acquired.	1	Processes & Procedures; Metrics; Acquisition; Resources
Establish a metric for DoD labs for the number of DoD lab-developed technologies that advance to DoD acquisition programs through T2 mechanisms (licenses and CRADAs).	1	Processes & Procedures; Metrics; Acquisition
Establish effective ways for DoD to learn of sales of new products to the U.S. military resulting from DoD lab T2 agreements, such as by requiring DoD T2 partners in their license agreements or CRADAs to report on these outcomes to the DoD lab.	1	Processes & Procedures
Establish metrics that measure the number of issued patents appropriate for DoD's total R&D expenditures and/or the size of the	2	Processes & Procedures; Metrics

S&E workforce, benchmarking these metrics against the comparables in other peer federal agencies, such as DOE and NASA.		
Establish metrics that measure the annual license revenues that are appropriate for the number of DoD license agreements and/or size of DoD's patent portfolio, benchmarking these metrics against the comparables in other federal agencies such as DOE and NASA.	3	Processes & Procedures; Metrics
Allow TTAs to be considered completed when an acquisition program sends funding to a DoD lab under a Military Interdepartmental Purchase Request (MIPR) for further technology development, usually for prototype development.	3	Processes & Procedures; Acquisition; Resources
Annually track the funds that are MIPRed from DoD acquisition programs to DoD labs for transition.	3	Processes & Procedures; Resources; Acquisition

Tier II: Solutions that will require some additional funding and/or policy changes

Recommendation	Rank	Category
Establish mechanisms and programs to help DoD licensees or CRADA partners who have developed critically needed military products based on their T2 agreements to sell these products to DoD.	1	Processes & Procedures; Acquisition
Establish mechanisms to enable DoD acquisition programs to become fully aware of new dual-use products resulting from DoD license agreements and CRADAs.	2	Processes & Procedures; Acquisition
Incentivize or strongly encourage prime contractors to subcontract with DoD licensees or CRADA partners when those companies can produce the needed technology at a significantly lower cost than the primes (like procedures with DoD SBIR-funded companies).	3	Strategy & Policies; Processes & Procedures; Acquisition
Establish a metric to measure intangibles from T2 such as S&E workforce knowledge advancement and satisfaction. These could be assessed through the S&E customer satisfaction survey mentioned above.	3	Processes & Procedures; Metrics
Establish a metric for SBIR products that were developed through CRADAs, either before or after the CRADA.	3	Processes & Procedures; Metrics

Establish metrics to measure improvements to DoD lab technology that result from T2 agreements.	4	Processes & Procedures; Metrics

Tier III: Solutions that require substantial additional funding and policy changes

Recommendation	Rank	Category
Establish well-funded programs to help DoD licensees and CRADA partners fully develop, productize, and transition technologies licensed from DoD labs or co-developed under CRADAs if there is a critical DoD need for products based on those technologies. Potential mechanisms could include providing a limited number of hours of "tech support" from the inventors, a grant program to cover the cost of DoD inventor assistance, and funding from DoD acquisition programs.	2	Strategy & Policies; Processes & Procedures; Resources; Acquisition
Establish a pilot program in each service that would enable an acquisition program to establish an indefinite delivery/indefinite quantity (IDIQ) contract with multiple companies to enable manufacture of small production quantities of new lab-developed technologies to evaluate how well these technologies perform before committing to acquisition.	3	Strategy & Policies; Processes & Procedures; Acquisition
Establish mechanisms to raise the quality of DoD patents, as measured by leading patent portfolio analysis software, to match the quality of peer federal agencies, such as DOE and NASA, and establish metrics to evaluate and track patent quality over time at the lab, component, and DoD laboratory system level.	4	Processes & Procedures; Metrics

End Outcomes

Tier I: Low-to-no-cost solutions that can be most readily implemented

Recommendation	Rank	Category
Establish metrics for the number of DoD lab-developed technologies that transition to DoD programs of record and DoD operational use through T2 mechanisms (licenses and CRADAs) at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics; Acquisition

Tier II: Solutions that will require some additional funding and/or policy changes

Recommendation	Rank	Category
Establish effective mechanisms to learn the end outcomes from DoD license agreements and CRADAs.	1	Processes & Procedures
Establish metrics to measure cost and time savings to DoD that result from T2 agreements.	1	Processes & Procedures; Metrics; Resources
Establish metrics to measure the number of innovative non-traditional companies recruited to the defense industrial base through T2 mechanisms at the lab, component, and DoD laboratory system levels.	1	Processes & Procedures; Metrics
Establish metrics that measure the qualitative outcomes not only to DoD but also to DoD's T2 partners. Information on these qualitative outcomes would be obtained through follow-up surveys.	1	Processes & Procedures; Metrics

Impacts

Tier I: Low-to-no-cost solutions that can be most readily implemented

Recommendation	Rank	Category
Establish metrics at the lab, component, and DoD laboratory system levels for qualitative success stories that show how public-private partnerships using T2 mechanisms have impacted or benefited the defense mission.	1	Processes & Procedures; Metrics
Establish metrics at the lab, component, and DoD laboratory system levels for qualitative success stories that illustrate how DoD T2 partnerships with industry and universities have led to existing company success, new startup companies, new dual-use products, job creation, economic development, and U.S. technological competitiveness.	1	Processes & Procedures; Metrics
Establish metrics at the DoD laboratory system level for qualitative success stories that illustrate how the DoD T2 system has created a stronger, more agile, and more reliable defense industrial base.	1	Processes & Procedures; Metrics

Tier II: Solutions that will require some additional funding and/or policy changes

Recommendation	Rank	Category
Estimate the return on investment (ROI) from DoD T2 in terms of both national economic impacts and impacts on the defense mission. This calculation would compare the total expenditures for DoD T2 to the total dollar-related outcomes. For national economic impacts, this calculation would apply IMPLAN modeling to the total sales of new products and services resulting from DoD T2 agreements to estimate their total economy-wide output and other quantifiable benefits. For impacts on the defense mission, this ROI calculation would estimate factors such as (1) the total cost savings to DoD from leveraging the resources and expertise of industry and academia through CRADAs, and (2) the total cost savings from procuring and fielding new technology developed in DoD's own labs and transferred to industry through license agreements for final development and manufacture.	1	Processes & Procedures; Resources

Establish mechanisms to estimate and track the number of acquisition dollars in the FYDP (5-yr window) that can be traced back to a documented DoD laboratory system T2 activity	2	Processes & Procedures; Resources; Acquisition
Establish ways to qualitatively measure other defense-mission impacts of new technologies transitioned to DoD operational use through the T2 mechanism, including impacts such as improved Warfighter agility, performance, and survivability.	2	Processes & Procedures; Metrics
Establish mechanisms to estimate how the DoD T2 system has resulted in enhanced national economic development, job creation, and increased U.S. technological competitiveness.	2	Processes & Procedures; Metrics