CHRISTY FORAN, LAUREN A. MAYER, JIM MIGNANO,
ANTHONY LAWRENCE, MARK V. ARENA, CORTNEY WEINBAUM,
SHANE MANUEL, ELIZABETH HASTINGS ROER, KELLER SCHOLL,
RICHARD SILBERGLITT, PETER WHITEHEAD

The Technology Promotion and Protection Decision Tool

Introduction and User Manual

For more information on this publication, visit **www.rand.org/t/RRA1244-1**.

Cover: Gorodenkoff/Getty Images.

About This Report

The U.S. government has developed hundreds of approaches to promote and protect critical technologies and their associated industrial base, and the sheer number and diversity of these programs, policies, and initiatives approaches present a logistical challenge for the U.S. Department of Defense (DoD). Upon discovering a risk or vulnerability to a critical technology, DoD must be able to quickly and effectively determine those relevant approaches that can mitigate the risk, and their related implementation considerations. This report provides supporting documentation for a tool to assist DoD in this approach selection. More specifically, we were asked by Strategic Technology Protection and Exploitation (STP&E) in the Office of the Under Secretary of Defense for Research and Engineering to develop a selection framework that (1) identifies relevant approaches based on features of the technology and strategy, (2) provides details on approach implementation considerations, and (3) is instantiated by an interactive tool for use by government entities to inform approach decisionmaking.

The Promotion and Protection (P&P) Tool resulting from this effort is a Microsoft Excel workbook with Visual Basic for Applications developed for use by DoD, as well as other government entities. This report provides an introduction to the tool, a review of its underlying selection framework, and two user manuals to facilitate its use by DoD administrators and government users. The P&P Tool should be useful to DoD and other government stakeholders interested in exploring options to promote or protect a critical technology, process, or service in which they have a vested interest.

The research reported here was completed in June 2022 and underwent security review with the sponsor and the Defense Office of Prepublication and Security Review before public release.

RAND National Security Research Division

This research was sponsored by the Strategic Technology Protection and Exploitation (STP&E) Division of the Office of the Under Secretary of Defense for Research and Engineering and conducted within the Acquisitions and Technology Policy Center of the RAND National Security Research Division (NSRD), which operates the National Defense Research Institute (NDRI), a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense intelligence enterprise.

For more information on the RAND Acquisitions and Technology Policy Center, see www.rand.org/nsrd/atp or contact the director (contact information is provided on the webpage).

Acknowledgments

Summary

Recent U.S. national security guidance renews the U.S commitment to sustain its innovation edge, through promotion and protection of cutting-edge technologies, as well as the associated people, capabilities, and knowledge (The White House, 2021). The U.S. government has developed hundreds of approaches (e.g., programs, policies, and initiatives) to implement these actions set forth in national guidance, ranging from those to protect intellectual property to those promoting defense sector access to emerging commercial technologies. These approaches are managed by various government entities and vary in their features, including their applicability (e.g., maturity of the technology, partnerships allowed), intended goals, and courses of action taken to achieve those goals. The sheer number and diversity of available approaches present a logistical challenge for the U.S. Department of Defense (DoD). Upon discovering a risk or vulnerability to U.S. science and technology innovation, DoD must be able to quickly and effectively determine relevant approaches that can mitigate the risk, and their related implementation considerations. This report provides supporting documentation for a tool to assist DoD in this approach selection.

The Promotion and Protection Tool

The Promotion and Protection (P&P) Tool documented in this report is a Microsoft Excel workbook with Visual Basic for Applications developed for use by DoD, as well as other government entities, to elicit pertinent information about a technology and/or strategy and return (1) a list of potentially relevant approaches with additional comparative information, to inform user decisionmaking about the approaches to select for further exploration, and (2) descriptive information, to provide implementation details and references to pursue for further research. To down-select the approaches that may be relevant for specific user inputs, the tool depends on an algorithm based on simple Boolean logic. User inputs are matched to an underlying database containing a set of available approaches that are characterized for the same features.

Components of the P&P Tool

The tool documented here contains data for 35 of the 192 approaches we identified. Thus, we designed it as a "living" tool, to be maintained by DoD, that includes administrator functionality to add more approaches and update existing ones in its underlying dataset. The P&P framework, therefore, includes two components. First, an Administrator Interface contains the approach database and allows an administrator to edit, add, and delete approaches in the database. This interface also includes functionality for the administrator to create a new version of the database of approaches for the User Tool as a separate Excel worksheet. It is within this User Tool that a user can provide inputs about the technology and/or strategy features

using a simple form (see left side of Figure S.1). Once inputs are provided, this worksheet displays the approaches that match the user's inputs (see right side of Figure S.1), and the user can navigate to a worksheet that includes information about the matching approaches, including basic comparison data and a short descriptive summary for each approach (Figure S.2). The worksheet further includes a set of navigation buttons that offer additional comparison data (e.g., Figure S.3), a button to navigate to information about why an approach was included or excluded based on their inputs, and detailed reports with reference information about each approach. Finally, the user can create a "User Report" from this worksheet, which provides a printable version of user inputs, approach results, and approach information.

FIGURE S.1
P&P Inputs Worksheet

FIGURE S.2
P&P Results Worksheet

FIGURE S.3

P&P Approach Comparison Worksheet

DoD Outcomes from Tool Use

While the primary aim of the P&P Tool is to provide rapid identification of relevant approaches and information about their implementation, it is also designed to provide users a "learning-by-doing" experience. That is, the tool facilitates users' understanding of the approach database and algorithm by allowing users to explore the rationale behind the tool's down-selection and iteratively refine their results. It further assists users in self-led down-selection by providing comparative information about potentially relevant approaches. As a result, users of the tool not only gain insight into a set of approaches for further research, but also an understanding of the decision space constructed by available approaches.

More broadly, as more approaches are added to the tool, exploring the decision space may help DoD to identify gaps in government support of science and technology innovation. If different realistic combinations of technology and strategy inputs to the tool lead to few or no approach result outputs, this may suggest the need for development of new government approaches in an area.

Contents

Figures and Tables

Figures

Tables

Introduction

The *Interim National Security Strategy Guidance* issued in 2021 directs action to "sustain America's innovation edge" (The White House, 2021, p. 17). It promises to "double down on science and technology investments, . . . protect our investments with vigilance and foresight, . . . expand our science and technology workforce [and] . . . bolster our scientific and technological base" (The White House, 2021, p. 17). This guidance states that such actions to protect and promote the people, capabilities, and knowledge associated with critical science and technology (S&T) are imperative to maintaining the United States' long-term economic security, as well as its competitive advantage against global adversaries and threats.

The U.S. government has developed hundreds of approaches (e.g., programs, policies, and initiatives) to implement these actions set forth in national guidance, ranging from those to protect intellectual property for defense acquisition programs through implementation of contracting requirements (Department of Defense Instruction [DoDI] 5010.44, 2019), to promoting defense sector access to emerging commercial technologies through incentivizing partnerships and reducing barriers to entry (U.S. Air Force, Technology Transfer and Transition, 2020; Defense Innovation Unit, 2020). These approaches are managed by various government entities, including the U.S. Department of Defense (DoD), its components, and government organizations outside of DoD. Such approaches also vary in their features, including their applicability (e.g., maturity of the technology, partnerships allowed), intended goals, and courses of action (COAs) taken to achieve those goals.

As DoD aims to support the *Interim National Security Strategic Guidance* of sustaining U.S. S&T leadership, the sheer number and diversity of available approaches present a logistical challenge for DoD. Upon discovering a risk or vulnerability to U.S. S&T innovation, DoD must address the following questions:

- What is the full set of approaches available to the government?
- Which of those approaches are relevant, such that they (1) are applicable to the specific circumstances of the technology, service, or process at risk, (2) implement mitigation strategies being considered, and/or (3) meet acceptability criteria determined by the government entity that will implement it?
- For those relevant approaches, what considerations and information are important to implement them, and where can more information be obtained?

This report provides supporting documentation for a tool to assist DoD in answering such questions. More specifically, we were asked by Strategic Technology Protection and Exploitation (STP&E) in the Office of the Under Secretary of Defense for Research and Engineering (OUSD[R&E]) to develop a selection framework that (1) identifies relevant approaches based on features of the technology and strategy,[1] (2) provides details on approach implementation considerations, and (3) is instantiated by an interactive tool for use by government entities to inform approach decisionmaking.

The Promotion and Protection (P&P) Tool resulting from this effort is a Microsoft Excel workbook with Visual Basic for Applications developed for use by STP&E, as well as other government entities, interested in answering the questions posed earlier in this section. It was designed to elicit pertinent information about a technology and/or strategy and return (1) a list of potentially relevant approaches with additional comparative information, to inform user decisionmaking about the approaches to select for further exploration, and (2) descriptive information, to provide implementation details and references to pursue for further research. To down-select the approaches that may be relevant for specific user inputs, the tool depends on an algorithm based on simple Boolean logic. User inputs of technology and/or strategy features (e.g., technology readiness level [TRL], dominant market sector, acceptable partners) are matched to an underlying database containing a set of available approaches that are characterized for the same features. The tool facilitates users' understanding of the approach database and algorithm by allowing users to explore the rationale behind the tool's down-selection and iteratively refine their results. It further assists users in self-led down-selection by providing comparative information about potentially relevant approaches. As a result, users of the tool not only gain insight into a set of approaches for further research, but also an understanding of the decision space constructed by available approaches.

We anticipate users of the tool to be government officers, initially across DoD, as the result of a request or a mandate that requires exploration of potential means to protect or promote a specific technology. The use cases could include advancement or protection of research and development (R&D), expansion and protection of manufacturing capacity, and development and protection of technology markets. The tool primarily is designed to be used to identify the relevant programs or processes for DoD users. However, it may have additional value in exploring options for a program office that is planning to acquire a new capability or in acquisition training to make the workforce aware of different mechanisms to promote and protect technology.

---

[1] For the remainder of the report, we use the term *technology* to refer to a technology, service, or process more broadly and the term *strategy* to refer to the strategy chosen to mitigate the risk or vulnerability to a technology, service, or process.

Development of the P&P Tool

We developed the P&P Tool using an iterative process, including four primary tasks, as shown in Figure 1.1. First, we identified the universe of available approaches (i.e., 192 identified approaches) and worked with STP&E to determine a subset of 35 that would be included in the initial tool delivered. In parallel, we performed a set of technology case studies to explore which features of a technology or strategy would be most useful when down-selecting approaches relevant to those features. This resulted in 12 features that we characterized for each approach included in the tool. Next, we developed a framework based on Boolean logic that would match features, provided as user inputs, to the features characterized for each approach (e.g., for a user with a technology at TRL 4, only those approaches relevant for technologies at this TRL would be returned). We then used the original cases, as well as new mini case studies, to test and iteratively refine the composition of the features and framework, until the framework returned a realistic set of approaches for the test cases. This framework will be further explained in Chapter Two.

We next focused on what information should be available for users to facilitate approach comparison and implementation considerations. This resulted in further characterization of the 35 approaches using both categorical and qualitative information. We combined the approach features, categorical information, and qualitative information with the selection framework to design a tool that would streamline and inform users' approach to decision-making. This process included iterative design of "screen shots" of a hypothetical tool to guide users through feature selection, approach results comparison, and implementation considerations. Finally, we developed an Excel tool to implement the design. Throughout

FIGURE 1.1
Process for P&P Tool Development
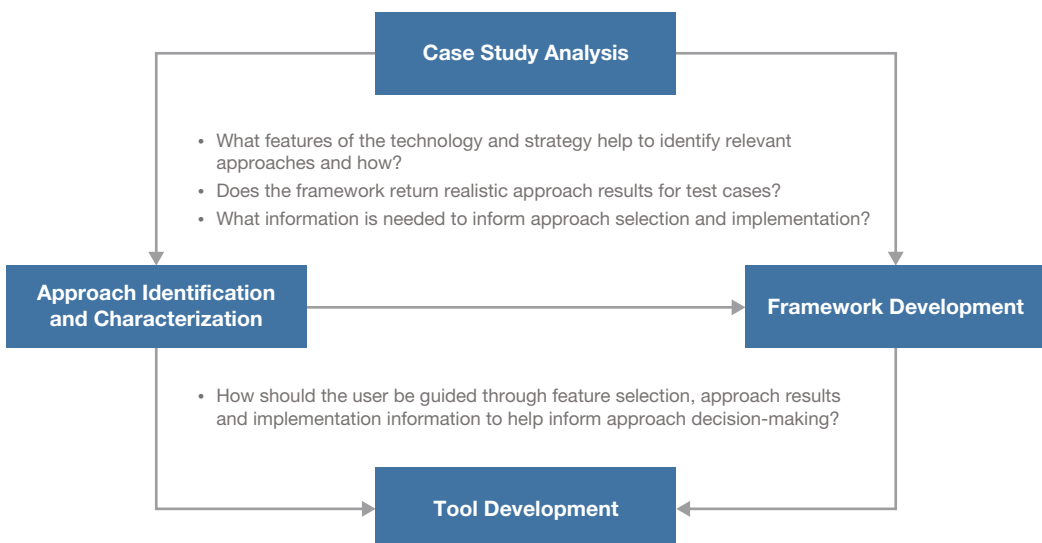
the entire process, we worked closely with STP&E stakeholders to ensure that the feature selection, framework development, and tool design was relevant to the decisions of the tool's intended audience. Further details of the methods and process to develop the P&P Tool are available in Appendix A.

Components of the P&P Tool

The tool was delivered to STP&E containing data for 35 of the 192 identified approaches. Thus, we designed it as a "living"' tool, to be maintained by STP&E and to include administrator functionality to add additional approaches and update existing ones in its underlying dataset.

This Administrator Interface includes the following components:

- *Database*: A relational database that includes a row for each of the 35 approaches. Features (e.g., TRL, dominant market, acceptable partners) are represented as columns in the database. Approaches are characterized for these features using a simple "1" (includes the feature) or "0" (does not include the feature).
- *Administrator Interface Worksheet*: An administrator interface that provides the following functionality:
  - *Administrator User Manual*: A button can be pressed to access the user manual for the Administrator Tool.
  - *Edit Approach Data*: The administrator can use a simple form to call an approach that is in the existing database, view its existing data, and edit the necessary fields.
  - *Add New Approach*: The administrator can use a simple form to define a new approach. The form includes each field necessary to complete a new row in the database.
  - *Delete Approach*: The administrator can choose an approach to delete from the dataset.
  - *Version Number*: When approaches are edited, added, or deleted, the administrator can change the version number in the Administrator Interface. All subsequent views of the approach database and generated user tools will have the new version number.
  - *Create a User Tool*: Given that approach data may change, the administrator can create and name a new user tool based on the current data in the Administrator Tool database.

The User Tool that is created contains the following components:

- *Read Me*: This worksheet provides some brief content about the version of the User Tool, reference information, and a link to access the user manual.
- *Database*: This database will match that in the Administrator Interface at the time the User Tool was created.

- *P&P Inputs*: On this worksheet, the user provides inputs about the technology and/or strategy features using a simple form. Once inputs are provided, this worksheet may be updated to view the approaches that match the user's inputs.
- *Approach Results*: After providing inputs, the user can navigate to a worksheet that includes information about the matching approaches, including basic comparison data and a short descriptive summary for each approach. The worksheet further includes a set of navigation buttons that offer additional comparison data, as well detailed reports with reference information about each approach. The worksheet also includes a button to navigate to information about why an approach was included or excluded based on their inputs. Finally, the user can create a "User Report" from this worksheet, which provides a printable version of user inputs, approach results and approach information.

Initial Set of Approaches Included in the Tool

Out of the 192 approaches identified in our initial exploration, we selected 35 approaches, with direction from STP&E, to include in the P&P Tool.[2] Table 1.1 provides a list of these approaches. The Administrator Interface provides an opportunity for STP&E to expand the number, type, and breadth of approaches in the tool's database.

Organization of This Report

The remainder of this report provides supporting documentation for the P&P Tool and the Administrator Interface. Chapter 2 describes the framework used to develop the tool's approach selection algorithm. In Chapters 3 and 4, we provide detailed user manuals for the tool user (e.g., government entity) and administrator, respectively. Chapter 5 concludes the main report with a short discussion of the tool's value to STP&E and DoD more broadly, as well as further research that may bolster the tool's impact. Four appendixes provide additional details. Appendix A presents our detailed methodology to develop the tool. Appendix B provides context for the tool's use by demonstrating a few applications of the selection framework with real-world case studies. Appendix C includes a table summarizing the 192 identified approaches. Appendix D provides a guide to the overviews of qualitative and categorical information embedded in the P&P User Tool for each of the 35 approaches contained in the final tool delivered to STP&E.

---

[2] An additional 13 approaches were characterized and added by STP&E. These approaches are not included in this report but were used to test the decision framework during our case study analysis.

TABLE 1.1

Initial Approaches Included in P&P Tool

Approach Category	Approach Name
Develop shared enterprise with industry	• Air Force Technology Transfer • Hosting 5G Demonstrations • Navy Technology Transfer (Navy T2)
Innovation and research investment	• Defense Advanced Research Projects Agency (DARPA) Investment • Defense Innovation Unit (DIU) Investment • Intelligence Advanced Research Projects Activity (IARPA) Investment • Multidisciplinary University Research Initiative (MURI) Investment • National Security Innovation Capital (NSIC) Investment • Rapid Innovation Fund Investment • Rapid Reaction Technology Office (RRTO) Investment • Research and Experimentation Tax Incentives
Industrial security and acquisitions policy	• Anti-Tamper and Technology Authentication • Critical Technology Protection • Domestic Content Restrictions • FBI Outreach • Information Classification Determinations • Program Protection • Technology Security and Foreign Disclosure (TS&FD) Processes
Policies and standards for intellectual property (IP) and data access	• IP Acquisition, Licensing, and Management • Patenting
International cooperation and agreements (non-investment)	• Import Actions (Section 232 Investigation) • International Cooperation and Agreements
Non-investment support of commercial or academic programs	• Business Acceleration • Industry and Academic Outreach and Coordination • International Science and Technology Engagement
Technology procurement and purchasing	• Arms Exports (Conventional Arms Transfer)
Capital investment and financing	• Energy Infrastructure Loans and Loan Guarantees • Small Business Investment Company (SBIC) Program Investment
Review of companies, investments, and mergers and acquisitions (M&A)	• None[a]
Review or limit technology distribution	• Export Controls (Commerce Control List) • Export Prohibitions (Lists of Parties of Concern)
Workforce-related programs	• Apprenticeship Expansion Grants • Apprenticeship Expansion Contracts • J-1 Visa Waivers • Job Corps Training and Education • Registered Apprenticeship Program Occupational Training

[a] No approaches in this category were reviewed by RAND for inclusion in the P&P Tool; however, approaches in this category were provided by STP&E.

Selection Framework

This chapter describes the framework developed to down-select a subset of the approaches available in the P&P Tool's dataset based on a set of tool user inputs. It will be of interest to those administrators and users who would like to understand why specific approach results are returned when certain inputs are provided. The chapter begins with an overview of the objective of P&P Tool selection framework and the context assumed for the tool's use. Next, it provides the features we chose for down-selection criteria and their rationale, followed by the algorithm used to perform the down-selection based on a specific set of user inputs. Finally, a brief example application of the algorithm is provided to assist in understanding.

Framework Aims and Context

As discussed in Chapter One, the P&P Tool is designed, in part, to elicit pertinent information about a technology and/or strategy and identify the approaches that *might* be relevant for that input information. The aim of the tool, therefore, is not to provide a list of definitively relevant approaches; instead, it is to filter out those approaches that are highly likely to be irrelevant, and list approaches for further exploration by the user. In other words, we designed the selection framework to be inclusive (i.e., ensure that relevant approaches are not filtered out, at the expense of including some irrelevant approaches in the results).

This purpose is consistent with how the tool is assumed to be used. As shown in Figure 2.1, we assume that tool use will be initiated by a government entity that has identified a technology problem (i.e., risk, issue, or opportunity), assessed the risk, and deemed action to be necessary. That entity approaches STP&E to assist in the identification of relevant approaches to address the problem. STP&E may either (1) elicit tool inputs from the entity and apply them to the tool or (2) provide the tool to this entity along with a user manual to use the tool itself. In both scenarios, the government entity will have to perform some upfront research (e.g., current state of the technology, appropriate strategy) to accurately determine the tool inputs. In the first scenario, STP&E would provide the tool results to the government entity, whereas in the latter scenario the entity determines the results itself. In either case, the responsibility to select a specific approach for implementation resides with the government entity. We assume that this responsibility includes the government entity referencing implementation information provided in tool outputs to perform further research on approaches of interest.

Assumed Use of P&P Tool
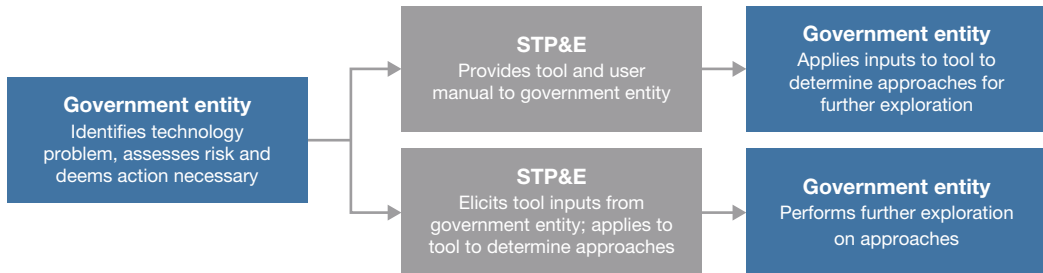
This research would confirm the relevance of the approach and provide additional information (e.g., from the lead program of an approach) for the specific circumstance of the technology problem.

Selection Features

The choice of an inclusive design for the selection framework was partially driven by the need to limit the number of features used as tool inputs. These limitations are common in user tools. First, there are physical restrictions (e.g., computer screen size) that must be considered when designing a user input interface. Second, ensuring that a user tool is tractable includes considering the cognitive load of the user to interact with the tool, as well as the barriers to tool use, which both increase with additional inputs elicited and information provided. Thus, the features presented as tool inputs comprise a subset of the numerous features that actually vary between approaches.

To determine the selection features that would be used as tool inputs, we used an inverted process. That is, we first determined how to consistently characterize the approaches for a set of categorical information that could allow for their comparison. Subsequently, we reframed this characterization to focus on the features of the technology and strategy that could align with each approach. As an example, we determined that approaches differ in the types of technologies they can accept. While some can only be used for technologies with commercial applications or defense applications, others can be used regardless of the technology's existing application. Reframing this to a tool input required the feature to characterize the existing application of the technology, as opposed to the types of technologies the approach can accept.

We initially characterized approaches for 23 categorical features that provided a reasonably comprehensive set to discriminate between approaches. Through case study analysis and stakeholder discussions, we determined that 12 of these features were most relevant to act as input variables, with the remaining relegated to categorical information that would be presented as part of tool outputs. This decision was based on whether the feature was likely to (1) be information a government entity could provide as an input (i.e., how knowable was the feature?), (2) be relevant for cases for which the tool would be used (i.e., how frequently would

the feature be used?), and (3) inform a user's decision of whether to pursue further exploration of an approach (i.e., how well does the feature discriminate between approaches that the user considers to be relevant versus irrelevant?).

After determining the features, we reframed them as tool inputs about the technology, strategy, or acceptable conditions, as shown in Table 2.1. This table presents the 12 features used as inputs, the categorical options available to the user for each feature, and general rules for user option selection.[1] It is worth noting that the user selection rules for a feature differ from how the features are characterized in the underlying relational database of approaches. For example, returning to the feature for existing applications of a technology, while the user may only select one existing application as an input (i.e., a technology can only have one type of existing application—commercial, dual-use, or defense), approaches may be coded in the database for more than one existing application (i.e., an approach may accept technologies with commercial or dual-use applications).

Selection Algorithm

To select the approaches returned as outputs in the tool, the framework matches feature options, provided as user inputs, to the same features characterized in the underlying approach database, using Boolean logic. In layman's terms, this algorithm requests the following:

1. Do not consider the features for which the user has not made an input selection.
2. Return the approaches that match on at least one option for all remaining features.

That is, this algorithm does not require the tool to match approach features that are left blank by the user. For the remaining features, it requires a match on all, but only for one option within each feature. This is shown pictorially in Figure 2.2.

Example Application of Selection Algorithm

To facilitate understanding of the selection algorithm, here we provide a brief example. For the purposes of this example, assume that there are only six approaches characterized for five features in the underlying database, as shown in Table 2.2. Now assume that a user provides the following input selections:

- TRL of the technology: 5, 6, and 7
- Existing applications of the technology: Defense
- Objective: No selections input
- Acceptable partners: Qualified small business, consortium
- Months for request: January, February, and March.

---

[1] Definitions, as well as inclusion and exclusion criteria for the features and selections, are provided in Chapter 3.

TABLE 2.1

Features Presented as Tool Inputs

Feature Type	Feature	Options	Rules
Strategy	Strategy objective	• Promotion: Technology innovation and development • Promotion: Industrial base manufacturing and capability • Protection: Technology and industrial base	Multi-selection
	Courses of action	20 options, for example • Foster a new or emerging technology, service, or process • Preserve/expand industrial base, e.g., increase manufacturing capacity • Limit foreign access to critical technology	Multi-selection
	Acceptable partners	6 options, for example • Qualified small business • Startup/venture capital • Consortium	Multi-selection
	Non-traditional defense contractor required	Yes	Leave blank if not required
Technology	TRL	10 options (TRL 1–9, and not applicable or unknown)	Multi-selection
	MRL	11 options (MRL 1–10, and not applicable or unknown)	Multi-selection
	Include software-only approaches	Yes	Leave blank if not software
	Existing applications	5 options, for example • Commercial/industry • Dual-use • Defense	Select one
	Dominant U.S. market	4 options, for example • Commercial/industry • Defense • Non-defense government	Select one; only applicable for dual-use
Acceptable conditions	Funding source type	All types (no preference) • Direct expenditures • Source other than direct expenditures	Select one
	Direct expenditure source	4 options, for example • Within OSD • Other DoD Component • Industry	Multi-selection; only applicable for direct expenditures
	Months to place request	12 options (January–December)	Multi-selection

NOTE: For features with many options, the number of options and a few examples are listed for brevity. The full set of options are provided in Chapter Three. MRL = manufacturing readiness level; OSD = Office of the Secretary of Defense.

FIGURE 2.2

Representation of the P&P Framework Algorithm
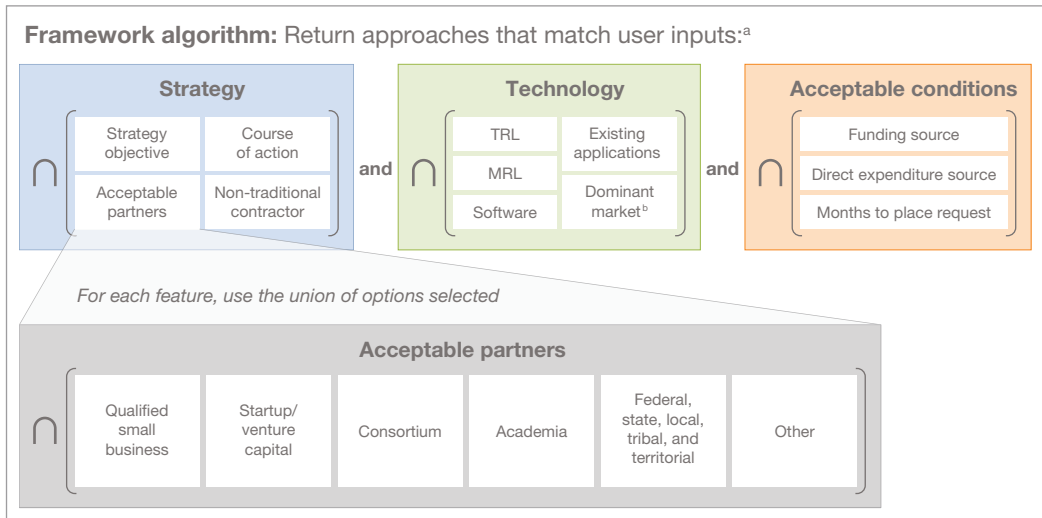
a If no options are selected for a feature, disregard that feature.
b Only applicable for dual-use application.

TABLE 2.2

Example Relational Database for Six Approaches and Five Features

Approach	TRL Accepted	Existing Applications Accepted	Objective	Partners Accepted	Months to Request
Export Controls	All	All	Protect technology and industrial base	All	All
IP Acquisition, Licensing, and Management	All	Defense, non-defense government, dual-use	All	Qualified small business, startup, academia, other defense contractor	All
Hosting 5G Demonstrations	All	Commercial	All	All	September–January
MURI Investment	1–3	No existing applications	Promote technology, promote industrial base	Academia	January–February
Rapid Innovation Fund Investment	4–6	All except "non-defense government"	Promote technology	Qualified small business	November–December
Apprenticeship Expansion Grants	All	All except "no existing applications"	Promote industrial base	Federal, state, local, tribal, territorial	All

To be returned as an output, an approach must match on at least one option for all selected features. This allows us to eliminate approaches that do not match on any one feature (i.e., if the approach does not match on any one feature, it will be eliminated even if it matches for all other features). Beginning with the TRL input of 5, 6, and 7, we can eliminate MURI investment (because it is only applicable for TRLs 1–3), leaving five remaining approaches. The existing application input of defense allows for Hosting 5G Demonstrations to be eliminated (because it is only applicable for commercial applications). Because the user provided no selection input for objective, we do not consider this in the matching exercise. Moving on to acceptable partners, Apprenticeship Expansion Grants can be eliminated because it does not include the user input of Qualified small business or consortium. While the approach of IP Acquisition, Licensing, and Management does match on the input of Qualified small business, it does not match on the input of consortium. Given that the algorithm records a match for a feature as long as one input option matches one coded selection in the underlying approach database, it is not necessary for both to match, so the IP approach can remain. Three approaches remain: Export Controls; IP Acquisition, Licensing, and Management; and Rapid Innovation Fund Investment. However, the user provided only January, February, and March as the acceptable months for a request, which eliminates Rapid Innovation Fund Investment (only includes November–December). In the end, this leaves two approaches that would be returned as outputs in the tool: Export Controls and IP Acquisition, Licensing, and Management.

Manual for the P&P User Tool

The Technology Protect and Promotion (P&P) user tool described in this chapter can be generated by the administrator of the P&P Tool and distributed to a range of potential users. This chapter provides step-by-step instructions for users to filter, select, and compare different approaches for government protection and promotion of technology.

First Use of the User Tool

The P&P user tool is an Excel workbook enabled with macros using Visual Basic for Applications (VBA). It is only compatible with a PC system and cannot be access on a mobile device or a tablet. The zipped folder containing the user tool and the files for each approach overview should be copied a local hard drive and all files from the zipped folder extracted into a single folder on the hard drive. The files must be located in the same folder for the tool to function. Go to the Excel file named "DemoUserTool" and open the file. The user tool uses VBA coded macros which need to be enabled on first use. When opening the P&P User Tool, Excel presents the following security warning in a yellow banner below the "ribbon." Click "Enable Content" to ensure that the tool can run by accessing its built-in macros.

SECURITY WARNING   Macros have been disabled.   Enable Content
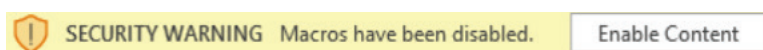
Overview of the P&P User Tool

The P&P User Tool[1] consists of the set of worksheets contained in the overall User Tool Excel workbook.[2] Keeping the "zoom" setting to 85 percent for the *P&P Inputs* and *Approach Results* worksheets allows the full width of the sheet to be viewed.

---

[1]   The User Tool is an Excel file created by the Administrator Interface, when performing the "Create a user tool" operation (see Chapter Four).

[2]   To help guide user workflow, all worksheets are hidden except the active worksheet. The user may navigate between tabs using buttons presented on the active worksheet.

- The *README* worksheet provides basic tool information and a navigation button to the *P&P Inputs* worksheet.
- *P&P Inputs*: On this worksheet, the user provides inputs about the features of a technology and/or strategy using a simple form. Once inputs are provided, this worksheet may be updated to view the approaches that match the user's inputs ("in") and those that do not match user inputs ("out").
- *Approach Results*: After providing inputs, the user can navigate to the *Approach Results* worksheet, which includes information about the matching approaches. Each matching approach includes basic comparison data, as well as buttons to navigate to a short descriptive summary and longer overview of each approach. From the *Approach Results* worksheet, a user can navigate to a number of other worksheets:
  - *Comparison Tables:* A dropdown menu allows the user to navigate to six tables that compare the matching approaches for a selected feature: Allowable Partners, Courses of Action, Funding Arrangements, Approach Risks, Funding Appropriations, and Precondition(s) to Use Approach.
  - *Match Summary*: Clicking "Match Summary" navigates to a table of all approaches (both "in" and "out") that indicates whether the features of each approach either match or do not match the inputs provided by the user. A user can navigate to further information on the underlying characterization of an approach of interest from this worksheet.
  - *User Report*: Clicking "Create User Report" creates a record of user inputs and the corresponding tool outputs for archive as a PDF file.
- A hidden worksheet contains informational material that comprise the underlying database characterizing to each approach. The tab labeled "Data" contains the current relational database. This worksheet captures the features that have been coded for each approach in the database. These data should not be altered or manipulated in the User Tool. If changes are required to the relational database, the P&P Tool administrator can use the functions described in Chapter Four.

How to Determine Relevant Approaches

This section contains step-by-step instructions for a user to provide inputs to down-select to a set of relevant approaches and to review information about the approaches to select those for their own further exploration. The instructions will lead the user through all the options for selection of approaches, including a set of definitions for each input feature.

Overview of the P&P Inputs Worksheet

Navigate from the *README* worksheet to the *P&P Inputs* worksheet (Figure 3.1). Users provide their inputs on the left side of the worksheet, which is composed of three sections of feature inputs: the identified technology strategy; the technology, service, or process of inter-

FIGURE 3.1
P&P Inputs Worksheet

est; and the acceptable conditions for consideration of an approach. The right side lists all approaches contained in the tool. Once a user provides inputs and clicks the "Run Analysis" button, the table on the right is updated to indicate those approaches that match and do not match. Five other buttons are available to the user:

- "Clear Selections" removes any user inputs from the left side.
- "README" returns the user to the *README* worksheet.
- "Approach Results" navigates to the *Approach Results* worksheet.
- "Match Summary" navigates to the *Approach Results* worksheet.
- "Comparison Tables" navigates to the worksheet allowing a user to pull down a set of tables that allows visualization of a comparison.

Enter Inputs on the P&P Inputs Worksheet

The *P&P Inputs* worksheet contains three sections for user inputs: "Characterize the Technology Strategy," "About the Technology, Service, or Process," and "Acceptable Conditions." Each section contains a number of features, and each feature contains one or more options. The selected options are used to filter down the approaches into those that are considered feasible or appropriate for use (approaches that are "in"). Users can leave any feature they choose blank or in their default condition (e.g., if it is unknown or they would rather not specify). When no options in a feature are selected, the tool will not filter approaches on that feature, returning a more inclusive number of approaches. Note that, if options are selected within a feature, the fewer options that are chosen, the more approaches the tool will filter out. We recommend being inclusive of all possible options within a feature at first, especially when faced with uncertainty, to provide the largest number of approach results, and iterating as

necessary or using the comparison information on the *Approach Results* worksheet to further down-select approaches. The following subsections review the purpose of each feature and definitions of the input options.

Technology Strategy Inputs

As explained in Chapter Two, we assume that the tool user has identified a technology problem (i.e., risk, issue, or opportunity), assessed the risk, and deemed action to be necessary. We will refer to this in the user manual as a use case. The first set of user inputs, with a blue background, pertains to the technology strategy the user is considering to mitigate the technology risk (Figure 3.2). If a strategy is not identified as part of the use case, then this section can be skipped. The technology strategy features describe the aims and objectives for a specific use case (see Figure 3.1). This section contains three user inputs:

- Strategy Objective(s): This describes the objectives of the strategy at a high level.
- Strategy Courses of Action: Courses of action describe how this objective would be achieved (e.g., through fostering a new technology).

Figure 3.2
"Technology Strategy" Section of the P&P Input Page

- Acceptable Partner(s): Acceptable partners lists the potential types of organizations that the government might partner with to implement an approach.

The "Strategy Objective(s)" input allows a user to limit the selected approaches to those that fall under one or more of three types: those that aim to promote technology innovation and development, those that aim to promote the industrial base, and those that aim to protect technology and the industrial base. The user is directed to include all the strategy objectives that apply. If the potential objective(s) is/are unknown, this category can be left blank and will not be used to match potential approaches. Descriptions for each of the strategy objectives are detailed in Table 3.1.

The "Acceptable Partner" input allows a user to consider which types of partners will need to be engaged in a specific case. The user should consider who is currently developing or producing the technology of interest and check all potential partners that apply. If no selection is made, then all potential partners will be considered. A description each type of potential partner is included in Table 3.2.

The "Strategy Courses of Action" input allows a user to define the potential COAs being considered to meet the strategy objectives for the specific use case. Each COA aligns with one or more strategy objectives (e.g., the COA "Tap commercial capability" can achieve the broader objectives of both technology promotion and protection). The tool selects approaches that match at least one selected COA. Therefore, the more COAs that are selected, the greater the number of approaches that will be filtered "in." Selecting additional COAs will increase (not decrease) the number of approaches that are to be considered. If no selection is made, then all COAs will be considered. Descriptions of each COA are provided in Table 3.3.

TABLE 3.1
Strategy Objectives

Strategy Objective Choices	Definition and Examples
Promotion: Technology innovation and development	Improvements needed to identify, create, or advance new technology (e.g., innovation programs, R&D, prototyping, development of derivative applications of commercial sources)
Promotion: Industrial base manufacturing and capability	Improvements needed to strengthen defense industrial base manufacturing and capability (e.g., Human Capital Development, Capacity, Demand/Supply, Diminished Manufacturing Sources [DMS])
Protection: Technology and industrial base	Improvements needed to mitigate adversary threats to the technology and industrial base (e.g., "operations security, information safeguarding, research protection, designed-in system protections, SCRM [supply chain risk management], software assurance, hardware assurance, anti-counterfeit practices, AT [Anti-Tamper], and program security related and engineering cyber-resilient activities" (DoDI 5000.83, 2021, p. 13)

TABLE 3.2
Acceptable Partners

Acceptable Partner Choices	Definition and Examples
Qualified small business	Registered business that qualifies as a small business under Small Business Administration (SBA) basic requirements based on size and sector standards (SBA, undated)
Startup/venture capital	Newly developed and typically privately held companies, often prior to production of a specific product or technology. Venture Capital refers to private equity investment organizations or individuals that seed startup companies.
Consortium	Coordinated group of member companies, which may include some academic, nonprofit, or trade organizations
Academia	Universities and other non-profit research organizations including federally funded research and development centers (FFRDCs) and some national laboratories
Federal, SLTT	Any part of federal, state, local, tribal, or territorial governments
Other defense contractors	Other non-specified partners, including but not limited to traditional and non-traditional defense contractors
Non-traditional	If the partner is known to be limited to non-traditional defense contractors, then "yes" should be checked to limit approaches to those that utilize that subset that use that partner status as a criterion.

TABLE 3.3
Strategy Courses of Action

Strategy COA Choices	Definition and Examples
Foster a new or emerging technology, service, or process	Provide direct early support to critical and emerging technology (C&ET) R&D (e.g., via investment in R&D, partnering, academic engagement).
Mature a new or emerging technology, service, or process into development	Provide direct support to bridge the "valley of death" (e.g., through prototyping, experimentation, testing, evaluation).
Improve manufacturing, e.g., remove inefficiencies	Reduce manufacturing risks and promote innovative manufacturing processes and methodologies (e.g., advanced manufacturing technologies and techniques).
Preserve/expand industrial base, e.g., increase manufacturing capacity	Preserve or expand critical defense industrial capacity at an affordable price (e.g., via investment in property, plant, and equipment; government acquisition of IP).
Tap commercial capability for government/defense purposes, e.g., incentivize production priorities	Benefit from the technological innovations available from a larger industrial base/commercial market (e.g., using commercial off-the-shelf [COTS] products and services; eliminating business practices that drive unnecessary defense-unique capabilities; tapping the global commercial market; outreach to non-traditional vendors).

Table 3.3—continued

Strategy COA Choices	Definition and Examples
Diversify and strengthen the supplier base	Ensure the supplier base is robust, secure, and diverse (e.g., through U.S. government sales, Foreign Military Sales [FMS]/Direct Commercial Sales [DCS], Foreign Military Financing [FMF], foreign and allied sustainment and parts contracts and sales, other commercial markets, foreign manufacturing and assembly agreements, recovery of costs through sale of surplus and obsolete materiel).
Leverage international R&D capabilities	Leverage international innovation and research capabilities (e.g., through information and personnel exchange, foreign testing, and exercises, jointly funded R&D).
Retain access to critical suppliers (from loss, sale, or merger and acquisition)	Plan and leverage contingencies for the loss or sale of sole, key, or unique suppliers (e.g., through government investment in existing suppliers; M&A review; government ownership; including costs of supplier preservation in budgets, acquisition plans, and resource allocations; Build Back Better).
Transfer government developed technology to the commercial sector	Provide return to taxpayer for government investment (e.g., through technology transfer; technology transition; IP licensing and management).
Understand the scale and composition of supplier base	Maintain comprehensive understanding of the actual and potential supplier base (e.g., number, location, and ownership of suppliers).
Understand the supplier's financial market	Maintain knowledge of the relevant venture and investment aspects that might affect suppliers (e.g., economic and financial forces; fragility of suppliers; ties to other investments).
Understand subcontractor suppliers for a program	Maintain and validate program-level supply information (e.g., verification of bill of materials [BOM] data; transparent use of approved vendors list [AVL]; comprehensive and accurate supplier data, including Federal Procurement Data System–Next Generation [FPDS-NG], SAM.gov, industry databases such as the ERAI counterfeit electronics database and the UK's Electronic Systems Community (ESCO) Council forum on counterfeit parts, government databases such as the Government Industry Data Exchange Program [GIDEP], national and international legal data such as court records, and supplier-specific records such as Juran's scorecard).
Develop and sustain the workforce	Develop and maintain a workforce that meets or exceeds labor market demands and security standards (e.g., through technical, scientific, and manufacturing education and training; personnel security, information security, and counterintelligence standards).
Leverage contractual requirements (i.e., for technology protection)	Ensure comprehensive compliance, including contractually, with all appropriate regulations and standards (e.g., Federal Acquisition Regulation [FAR], Defense Federal Acquisition Regulation Supplement [DFARS], National Institute of Standards and Technology Special Publication [NIST SP] 800).
Manage Foreign Ownership, Control, or Influence (FOCI)	Understand, document, and mitigate national security risks arising from foreign influence and networks (e.g., knowledge of ownership of domestic suppliers, knowledge of foreign suppliers, foreign investment review/Committee on Foreign Investment in the United States [CFIUS], compliance with Trade Agreements Act [TAA]).

Table 3.2—continued

Strategy COA Choices	Definition and Examples
Limit foreign access to critical technology	Regulate the export of C&ET articles and services to prevent acquisition by strategic competitors (e.g., through International Traffic in Arms Regulations [ITAR]/Export Administration Regulations [EAR]; multilateral export control regimes; IP protections).
Assure U.S. government access to strategic materials	Maintain knowledge of strategic materials provenance and supply chain (e.g., foreign suppliers; foreign ownership or influence of domestic suppliers of strategic materials; conflict materials).
Secure critical information and technologies in the supply chain	Consistently and appropriately use supply chain controls inspections, and testing (e.g., National Industrial Security Program Operating Manual [NISPOM], Department of Defense Manual [DoDM] 5220.22, Executive Order [EO] 12829); anti-tamper technology; counterfeit detection, identification, and removal methodologies: monitoring the supply network, tracking supply chain deviations through intelligence and financial data).
Protect critical information and technologies from cyber threats	Ensure National Security Innovation Base (NSIB) entities implement appropriate cybersecurity practices and processes and maintain knowledge and understanding of the software/cyber issues in the supply chain (e.g., by proper classification of IP; use of industry standard secure development practices; knowledge of code provenance, authorship, and supply chain vulnerabilities).
International actions to maintain national competitiveness	Maintain technological advantage vis-à-vis adversaries (e.g., export; sales; ownership/control; sources).

Technology Inputs

The second set of user inputs, with a yellow background, pertains to the current state of the specific technology under consideration (see Figure 3.3). If a specific technology is not identified as part of the use case, then this section can be skipped. This section contains five user inputs: technology readiness level (TRL), manufacturing readiness level (MRL), inclusion of software-specific approaches, and two inputs about the current economic market for the technology.

The TRL input allows a user to input the current maturity of the technology. If the TRL is uncertain, the user should enter a range of TRLs. If no TRLs are selected, this input will not be considered when down-selecting among the available approaches. Definitions for each TRL are detailed in Table 3.4 from the U.S. Government Accountability Organization's (GAO's) *Technology Readiness Assessment Guide* (GAO, 2020).

The MRL input allows a user to input the current manufacturing maturity of the technology. If the MRL is uncertain, the user should enter a range of TRLs. As with TRL, when no MRLs are selected the input is not used in down-selecting among the available approaches. Definitions for each MRL are detailed in Table 3.5 from the Office of the Secretary of Defense (OSD) Manufacturing Technology Program's 2020 *Manufacturing Readiness Level (MRL) Deskbook* (Office of the Secretary of Defense Manufacturing Technology Program, 2020).

Below the MRL section, the tool asks the user to indicate whether approaches that are only used to develop or acquire software should be included. If "yes" is checked, then approaches that are only applicable to software are included. Note that most approaches apply both to software and non-software technology applications. These approaches are relevant whether the technology is or is not software and are included regardless of the input selected in the

FIGURE 3.3

The "About the Technology, Service or Process" Section of the User Input Page

TABLE 3.4

Definitions of Each TRL from GAO's *Technology Readiness Assessment Guide*

TRL	Description
1. Basic principles observed and reported	Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
2. Technology concept and/ or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative
4. Component and/ or breadboard validation in a laboratory environment	Basic technological components are integrated to establish that they will work together. This is relatively low fidelity compared with the eventual system. Examples include integration of ad hoc hardware in the laboratory.
5. Component and/ or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include high-fidelity laboratory integration of components.
6. System/ subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7. System prototype demonstration in an operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring the demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).
8. Actual system is completed and qualified by test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of the true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational conditions.

SOURCE: Reprinted verbatim from GAO, 2020, p. 11.

TABLE 3.5
Manufacturing Readiness Level Descriptions

MRL	Definition
1	Basic manufacturing implications identified
2	Manufacturing concepts identified
3	Manufacturing proof-of-concept identified
4	Capability to produce the technology prototype components in a laboratory environment
5	Capability to produce the technology prototype components in a production relevant environment
6	Capability to produce a prototype system or subsystem in a production relevant environment
7	Capability to produce systems, subsystems, or components in a production representative environment
8	Pilot line capability demonstrated; ready to begin Low Rate Initial Production (LRIP)
9	Low rate production demonstrated; capability in place to begin Full Rate Production (FRP)
10	Full rate production demonstrated and lean production practices in place

SOURCE: Office of the Secretary of Defense Manufacturing Technology Program, 2020.

software question. If the user does not check "yes" under the software question, then only approaches that are ambivalent about software as products are included.

The last two technology inputs are concerned with currently available applications of the technology (see Table 3.6 for input options). A user should indicate the type of end use for which the technology being considered is *currently designed*. The current application could be one of these options: defense, dual-use, or commercial/industry applications. The values that can be selected from the drop-down menu are defense, dual-use, commercial/industry, no existing applications, or N/A or unknown. Only one option can be selected. If the current use of the technology is in the commercial or industrial sector, then commercial/industry applications should be selected. If the current use of the technology is for military applications, then defense should be selected. According to a session held at the National Academies in 1997, "the dual-use distinction is reserved for technology that has a significant government application and a private sector application, especially as the government application pertains to national security" (National Research Council, 1997). "No existing applications" should only be selected if the technology is too immature for applications to be known.

If the currently available applications of the technology are considered dual-use, then an additional question opens for user input. A user should indicate where the majority of demand for the technology is located. The values that can be selected are N/A or unknown,

TABLE 3.6

Definitions Technology Application Inputs

Input	Value	Definition
Existing applications are:	Commercial/industry	Applications of the technology are "customarily used for nongovernmental purposes" or "evolved through advances in technology or performance and . . . not yet available in the commercial marketplace but will be available in the commercial marketplace" in time for application of the approach
	Defense	Applications of the technology are specifically designed for defense purposes
	Nondefense government	Applications of the technology are specifically designed for nondefense governmental purposes
	Dual-Use	Applications of the technology are neither customarily used for nongovernmental purposes nor specifically designed for governmental purposes, but "are capable of meeting requirements for military and nonmilitary applications"
	No existing applications	Applications of the technology are "not yet available" and "will not be available in time" for application of the approach
	N/A or unknown	Applications of the technology are not applicable in this use case or not yet known
Only if "Dual-Use" selected above, existing U.S. applications are dominated by the following market:	Commercial/industry	Applications of the technology are customarily sold, leased, or licensed to the general public
	Defense	Applications of the technology are customarily sold, leased, or licensed to DoD or its components
	Nondefense government	Applications of the technology are customarily sold, leased, or licensed to the government, excluding DoD or its components
	No U.S. market dominates	Applications of the technology are customarily sold, leased, or licensed to both the general public and the government
	N/A or unknown	The market for this use case is either not applicable or unknown

SOURCES: Defense Acquisition University (DAU), 2020; 10 U.S.C. 2500.

commercial/industry, defense, nondefense government, and no U.S. market dominates. In this question, only a single market sector can be selected.

Acceptable Conditions Inputs

The third set of user inputs, with a green background, refers to the conditions or constraints that the user may have in selecting an approach (see Figure 3.4). If a user does not have constraints either in terms of timing or funding availability that affect their consideration of an approach, then this section could be skipped. When the intent is to explore the relevant approaches without limitations of cost and timing, adding inputs to this section would reduce the number and variety of approaches that are identified. Two user inputs are included: the types of funding arrangements and the acceptable months to place requests.

The first question asks whether the user would like to consider approaches that require a specific type of funding. The default option is for approaches with all types of funding to be considered. Additional options include approaches with funding from direct expenditures (investment approaches) and those that do not require funding direct expenditures (non-investment approaches). If approaches are limited to investments requiring direct expenditures, a follow-on question appears that requests the user to choose from different potential sources of those funds. The potential options for funding sources are from within OSD, from another DoD component, from industry, or from another government source outside DoD. The user should select all funding sources that may apply in order to consider the broadest possible set of approaches. When non-investment approaches are being considered, the funding source question is not relevant and therefore will not appear. When all types of approach funding are being considered, approaches with all potential sources of funding will be included.

The second question in the Acceptable Conditions section asks the user to select which months are acceptable to place requests for the current use. If a user has a use case in January that requires a response within 90 days, they should select January, February, and March. Only approaches that can be initiated in the specific months that are checked will be included in the tool's results. Note that if this section is unused (all months unchecked), it will not

FIGURE 3.4

The "Acceptable Conditions" Section of the User Input Page

be considered in the down-selection of approaches. Selecting "all months" and leaving all months blank has the same effect on the filtration process.

Run Analysis on the P&P Inputs Page

As each input is considered and selected, the results on the right side of the worksheet are updated to those that are filtered "in" with the selected inputs and those that are filtered "out." Information for the matching approaches is filtered on the other results pages, Approach Results Matching Summary, and Comparison Tables.

On the right side of the *P&P Inputs* worksheet is a table containing a full list of all included approaches (see Figure 3.5). After selecting inputs and clicking "Run Analysis," this table is automatically sorted to show the included, or "in," approaches at the top of the table and the excluded, or "out," approaches at the bottom of the table. The first column of the table contains an identification number. Each approach is associated with the same unique number throughout the tool. The approach name and a summary are also displayed.

FIGURE 3.5

Table of Approaches on the User Input Page

Approach Number	Approach Name	Summary
4	Export Controls (Commerce Control List)	Restricts the export of "core technologies and other items that are capable of being
6	Export Prohibitions (Lists of Parties of Concern)	Lists of parties of concern are forms of export control directed at specific end users
7	Patenting	The approach detailed here is working with industry and academic partners to assist
11	Intellectual Property Acquisition, Licensing, and	Acquiring and licensing the appropriate IP is vital for ensuring [weapon and
15	Industry & Academic Outreach and Coordination	A variety of programs centered on outreach to industry and academic researchers,
20	Air Force Technology Transfer	Tech transfer promotes technological innovation and commercialization through a
22	Anti-Tamper and Technology Authentication	Anti-Tamper (AT) are measures that are intended to prevent and/or delay the
30	Program Protection	"The integrating process for managing risks to DoD warfighting capability from foreign
31	Critical Technology Protection	Clears U.S. companies under the National Industrial Security Program to safeguard
33	Defense Advanced Research Projects Agency (DARPA)	Makes "pivotal investments in breakthrough technologies for national security"
36	Defense Innovation Unit (DIU) Investment	"The DIU mission is to accelerate innovation in the commercially-focused technology
51	Domestic Content Restrictions	The federal government is broadly required to purchase American-made goods when
58	Hosting 5G Demonstrations	DoD "has begun hosting 5G at-scale prototyping and experimentation in
62	International Science and Technology Engagement	DoD's International S&T Engagement Strategy "provides a framework to unify [...]
65	J-1 Visa Waivers	Visa wavers allow select individuals to stay in the US for longer periods of time, and
72	Multidisciplinary University Research	"[S]upports basic research in science and engineering at U.S. institutions of higher
73	Information Classification Determinations	Three federal information classification programs—National Security Information,
74	National Security Innovation Capital (NSIC)	NSIC is a DoD program under Defense Innovation Unit (DIU) that provides capital and
76	Navy Technology Transfer (Navy T2)	Tech transfer promotes technological innovation and commercialization through a
80	Rapid Innovation Fund Investment	The Rapid Innovation Fund is designed to transition small business technologies into
81	Rapid Reaction Technology Office (RRTO) Investment	The RRTO is geared toward "[l]everaging traditional and non-traditional sources of
91	Technology Release and Foreign Disclosure (TS&FD)	DoD policy is to transfer dual-use and defense-related technologies only in pursuit of
118	Energy Infrastructure Loans and Loan Guarantees	The Department of Energy's Loan Program Office provides debt financing through
120	Intelligence Advanced Research Projects Activity	IARPA is an intelligence community activity subordinate to the Director of National
124	International Cooperation and Agreements	This approach includes two forms of international agreement: 1) bilateral investment
130	FBI Outreach	FBI has three Private Sector programs that provide intelligence sharing venues
138	Apprenticeship Expansion Grants	The Department of Labor, Employment and Training Administration (ETA) administers
142	Apprenticeship Expansion Contracts	The Department of Labor, Employment and Training Administration (ETA) awarded 12
144	Job Corps Training and Education	The Department of Labor administers Job Corps, which is a vocational training and
147	Registered Apprenticeship Program Occupational	Apprenticeships are intended to provide cost-effective occupational training and
161	Small Business Investment Company (SBIC) Program	Through the program, the Small Business Administration "partners with privately
166	Arms Exports (Conventional Arms Transfer)	"The sale of U.S.-origin armaments and other 'defense articles'" to eligible foreign
186	Research and Experimentation Tax Incentives	Federal research and experimentation (R&E) tax incentives (deductions and credits)
445	Import Actions (Section 232 Investigation)	Section 232 of the Trade Expansion Act of 1962 authorizes the President to restrict
446	Business Acceleration	Accelerators offer competitive and structured programs focused on scaling the

From here, the user has two choices. If the preview of the approach results is not as expected (e.g., too long or too short), they can change their input selections. If they are content with the results, they can press the "Approach Results" button to explore information about the down-selected approaches.

Exploring Relevant Approaches

Pressing the "Approach Results" button on the *P&P Inputs* worksheet navigates the user to the *Approach Results* worksheet, which displays information about all the approaches that are filtered "in" based on the user inputs. This section contains step-by-step instructions to explore information about the relevant approaches.

Overview of the Approach Results Worksheet

The *Approach Results* worksheet (Figure 3.6) is intended to provide an overview and comparison of all the approaches relevant to the user inputs. The worksheet contains a table providing a comparison of the identified approaches across a set of categorial information. Next to each approach is an "Info" button, which displays summary information about that approach, and an "Overview" button, which opens a PDF overview of the specific approach. Appendix D describes these overview reports.

The worksheet also includes five navigation buttons at the top:

- "README" returns the user to the *README* worksheet.
- "P&P Inputs" will take the user back to the *P&P Inputs* worksheet.
- "Match Summary" navigates to a worksheet that allows the user to explore why certain approaches were filtered in or out according to their inputs.

FIGURE 3.6

Overview of the Approach Results Worksheet

Approach Number	Approach Name	Approach Category	Promote or Protect?	Entering TRL	Entering MRL	Request Months	Congressional Action Required	Investment Size	Lead Program	Other Services with Equivalent Approaches	Summary Information	Overview Report
4	Export Controls (Commerce Control List)	Review or limit technology distribution	Protect	All	All	Jan-Dec	No	n/a	Non-DoD federal agency	OSD/DoD Agency	Info	Overview
6	Export Prohibitions (Lists of Parties of Concern)	Review or limit technology distribution	Protect	All	All	Jan-Dec	No	n/a	Non-DoD federal agency		Info	Overview
7	Patenting	Policies and standards for intellectual property and data access	Both	All	All	Jan-Dec	No	unknown	Non-DoD federal agency		Info	Overview
11	Intellectual Property Acquisition, Licensing, and Management	Policies and standards for intellectual property and data access	Both	All	All	Jan-Dec	No	unknown	OSD	Air Force,Army,Navy	Info	Overview
15	Industry & Academic Outreach and Coordination	Non-investment support of commercial or academic programs	Promote	All	All	Jan-Dec	No	unknown	OSD	Air Force,Army,Navy	Info	Overview
20	Air Force Technology Transfer	Develop shared enterprise with industry	Promote	All	All	Jan-Dec	No	unknown	Air Force	OSD/DoD Agency,Army,Navy	Info	Overview
22	Anti-Tamper and Technology Authentication	Industrial security and acquisitions policy	Protect	All	All	Jan-Dec	No	n/a	DoD agency		Info	Overview
30	Program Protection	Industrial security and acquisitions policy	Protect	All	All	Jan-Dec	No	n/a	OSD		Info	Overview
31	Critical Technology Protection	Industrial security and acquisitions policy	Protect	All	All	Jan-Dec	No	n/a	DoD agency		Info	Overview
33	Defense Advanced Research Projects Agency (DARPA) Investment	Innovation and research investment	Promote	1-6	All	Jan-Dec	No	Range:$2M-$82M	DoD agency		Info	Overview
36	Defense Innovation Unit (DIU) Investment	Innovation and research investment	Promote	6-9	All	Jan-Dec	No	Avg:$3M	OSD		Info	Overview
51	Domestic Content Restrictions	Industrial security and acquisitions policy	Both	All	All	Jan-Dec	No	n/a	DoD agency		Info	Overview
58	Hosting 5G Demonstrations	Develop shared enterprise with industry	Both	All	All	Jan,Sep-Dec	No	Avg:$120M	DoD agency		Info	Overview
62	International Science and Technology Engagement	Non-investment support of commercial or academic programs	Promote	All	All	Jan-Dec	No	unknown	OSD	Air Force,Army,Navy	Info	Overview
65	J-1 Visa Waivers	Workforce-related programs	Promote	All	All	Jan-Dec	No	n/a	Non-DoD federal agency		Info	Overview
72	Multidisciplinary University Research Initiative (MURI) Investment	Innovation and research investment	Promote	1-3	All	Jan-Feb	No	Avg:$1.25-1.5M	OSD		Info	Overview
73	Information Classification Determinations	Industrial security and acquisitions policy	Protect	4-9	10-Apr	Jan-Dec	No	n/a	Non-DoD federal agency	OSD/DoD Agency,Air Force,Army,Navy	Info	Overview

- "Comparison Tables" allows the user to explore included approaches across a number of different features.
- "Create User Report" prints user inputs and tool outputs for archival purposes as a PDF.

View Basic Information About Approaches

Figure 3.7 shows the basic information table provided about each approach on the *Approach Results* worksheet, which can be further filtered and sorted by clicking the down arrows in the column headers. The table contains the approach name, unique identifier number associated with that approach, and the general category of approach to which it is assigned, as introduced in Table 1.1. The table also includes categorial information that describe the approach. Some align with the input features described earlier in this chapter. Whether an approach can be considered for protection, promotion, or both is reflected in the table. The TRL and MRL that are appropriate for consideration of the approach is also listed. If an approach could be used for a technology at any TRL, the table will report "All" under TRL for that approach. "Request Months" lists the months during which a request can be made for implementation of that approach.

Also listed are several categorical variables that may inform which approaches are of further interest. The "Congressional Action Required" column reflects whether congressional action must precede/authorize the execution of an approach. An "Investment Size" column reports the average amount (or range) of funding per project supported by an investment approach. Non-investment approaches are shown as "Not Applicable." The "Lead Program" column reflects the entity that administers/executes the specific approach; the field values for this category are OSD, Air Force, Army, Navy, DoD agency, non-DoD federal agency, SLTT (state, local, tribal, or territorial), and Other. A final column labeled "Other Services with Equivalent Approaches" indicates whether an additional entity administers/executes an approach (shares mission, shares objectives, may share a name with the primary entity responsible for the approach). If applicable, results in this column may include any combination of OSD/DoD Agency, Air Force, Army, or Navy.

FIGURE 3.7

Table of Approaches on the Approach Results Page

Approach Number	Approach Name	Approach Category	Promote or Protect?	Entering TRL	Entering MRL	Request Months	Congressional Action Required	Investment Size	Lead Program	Other Services with Equivalent Approaches	Summary Information	Overview Report
4	Export Controls (Commerce Control List)	Review or limit technology distribution	Protect	All	All	Jan-Dec	No	n/a	Non-DoD federal agency	OSD/DoD Agency	Info	Overview
6	Export Prohibitions (Lists of Parties of Concern)	Review or limit technology distribution	Protect	All	All	Jan-Dec	No	n/a	Non-DoD federal agency		Info	Overview
7	Patenting	Policies and standards for intellectual property and data access	Both	All	All	Jan-Dec	No	unknown	Non-DoD federal agency		Info	Overview
11	Intellectual Property Acquisition, Licensing, and Management	Policies and standards for intellectual property and data access	Both	All	All	Jan-Dec	No	unknown	OSD	Air Force,Army,Navy	Info	Overview
15	Industry & Academic Outreach and Coordination	Non-investment support of commercial or academic programs	Promote	All	All	Jan-Dec	No	unknown	OSD	Air Force,Army,Navy	Info	Overview
20	Air Force Technology Transfer	Develop shared enterprise with industry	Promote	All	All	Jan-Dec	No	unknown	Air Force	OSD/DoD Agency,Army,Navy	Info	Overview

Compare Approaches by Features

At the top of the *Approach Results* worksheet is a navigation button labelled "Comparison Tables" with a drop-down menu allowing the user to "Select Table." The options in the drop-down menu are Allowable Partners, Approach Risks, Courses of Action, Funding Arrangements, Funding Source, and Precondition(s) to Use Approach. Selection of any one of these options takes the user to a worksheet displaying the relevant table.

The Allowable Partners table shows all types of industrial base/targeted entity partners for which an approach is intended to assist (see Figure 3.8), as defined in Table 3.2.

The COA comparison table (Figure 3.9) shows the full list of included or "in" approaches and each course of action, as defined in Table 3.3.

The Funding Source comparison table shows all the potential sources of funding for an identified approach that are based on direct investments (see Figure 3.10). All potential sources of funding for the investment are identified in the columns that follow—from within OSD, from another DoD component, from industry, or from some other government source. If an approach does not require a direct investment, then no sources will be identified.

FIGURE 3.8
An Example of a "Compare By" Table of Allowable Partners

Approach Number	Approach Name	Qualified Small Business	Startup/Venture Capital	Consortium	Academia	Federal, SLTT	Other defense contractors (traditional and non-traditional)	Traditional Partners	Non-Traditional Partners
4	Export Controls (Commerce Control List)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
6	Export Prohibitions (Lists of Parties of Concern)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
7	Patenting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
11	Intellectual Property Acquisition, Licensing, and Management	Yes	Yes	-	Yes	-	Yes	Yes	-
15	Industry & Academic Outreach and Coordination	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
20	Air Force Technology Transfer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
22	Anti-Tamper and Technology Authentication	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
30	Program Protection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
31	Critical Technology Protection	Yes	Yes	-	Yes	Yes	Yes	Yes	-
33	Defense Advanced Research Projects Agency (DARPA) Investment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
36	Defense Innovation Unit (DIU) Investment	Yes	Yes	-	-	-	Yes	Yes	-
51	Domestic Content Restrictions	Yes	Yes	Yes	-	-	Yes	Yes	-
58	Hosting 5G Demonstrations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
62	International Science and Technology Engagement	Yes	Yes	Yes	Yes	-	Yes	Yes	-
65	J-1 Visa Waivers	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
72	Multidisciplinary University Research Initiative (MURI) Investment	-	-	-	Yes	-	-	-	-
73	Information Classification Determinations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
74	National Security Innovation Capital (NSIC) Investment	Yes	Yes	-	-	-	-	-	-

FIGURE 3.9
An Example of a "Compare By" Table of Courses of Action

Approach Number	Approach Name	Foster a new or emerging technology, service, or process	Mature a new or emerging technology, service, or process into development	Improve manufacturing, e.g. remove inefficiencies	Preserve/expand industrial base, e.g. increase manufacturing capacity	Tap commercial capability for government/defense purposes, e.g. incentivize production priorities
4	Export Controls (Commerce Control List)	-	-	-	-	-
6	Export Prohibitions (Lists of Parties of Concern)	-	-	-	-	-
7	Patenting	Yes	-	-	-	Yes
11	Intellectual Property Acquisition, Licensing, and Management	-	-	Yes	Yes	Yes
15	Industry & Academic Outreach and Coordination	Yes	Yes	-	-	Yes
20	Air Force Technology Transfer	Yes	Yes	-	-	Yes
22	Anti-Tamper and Technology Authentication	-	-	-	-	-
30	Program Protection	-	-	-	-	-
31	Critical Technology Protection	-	-	-	-	-
33	Defense Advanced Research Projects Agency (DARPA) Investment	Yes	Yes	-	-	-
36	Defense Innovation Unit (DIU) Investment	Yes	Yes	-	-	Yes

FIGURE 3.10

An Example of a "Compare By" Table of Funding Source

Approach Number	Approach Name	Within OSD	Other DoD Component	Industry	Other government
4	Export Controls (Commerce Control List)	-	-	-	-
6	Export Prohibitions (Lists of Parties of Concern)	-	-	-	-
7	Patenting	-	-	Yes	-
11	Intellectual Property Acquisition, Licensing, and Management	Yes	Yes	-	-
15	Industry & Academic Outreach and Coordination	Yes	Yes	Yes	Yes
20	Air Force Technology Transfer	-	Yes	Yes	-
22	Anti-Tamper and Technology Authentication	-	-	-	-
30	Program Protection	-	-	-	-
31	Critical Technology Protection	-	-	-	-
33	Defense Advanced Research Projects Agency (DARPA) Investment	Yes	Yes	-	-
36	Defense Innovation Unit (DIU) Investment	Yes	Yes	Yes	-
51	Domestic Content Restrictions	-	-	-	-
58	Hosting 5G Demonstrations	Yes	Yes	-	-
62	International Science and Technology Engagement	Yes	Yes	-	-
65	J-1 Visa Waivers	-	-	-	-
72	Multidisciplinary University Research Initiative (MURI) Investment	-	Yes	-	-
73	Information Classification Determinations	-	-	-	-
74	National Security Innovation Capital (NSIC) Investment	Yes	Yes	-	-
76	Navy Technology Transfer (Navy T2)	-	Yes	Yes	-
80	Rapid Innovation Fund Investment	-	Yes	-	-
81	Rapid Reaction Technology Office (RRTO) Investment	Yes	Yes	-	-
91	Technology Release and Foreign Disclosure (TS&FD) Processes	-	-	-	-

The Approach Risks comparison table shows the potential risk involved in using each identified approach (see Figure 3.11). The categories of approach risk are described in DoD's *Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs* (DoD, 2017). Each approach is considered for its potential to fail due to technical risks (testing, manufacturing, etc.), due to programmatic risks (program execution, cost estimates, etc.) or due to business risks (market factors, foreign investment, etc.). Descriptions of each approach can be found in Table 3.8.

FIGURE 3.11

An Example of a "Compare By" Table of Approach Risks

Approach Number	Approach Name	Technical Risks	Programmatic Risks	Business (External) Risks
4	Export Controls (Commerce Control List)	-	Yes	Yes
6	Export Prohibitions (Lists of Parties of Concern)	-	Yes	Yes
7	Patenting	-	Yes	Yes
11	Intellectual Property Acquisition, Licensing, and Management	-	Yes	Yes
15	Industry & Academic Outreach and Coordination	-	Yes	Yes
20	Air Force Technology Transfer	-	-	Yes
22	Anti-Tamper and Technology Authentication	Yes	Yes	Yes
30	Program Protection	-	Yes	-
31	Critical Technology Protection	-	Yes	-
33	Defense Advanced Research Projects Agency (DARPA) Investment	Yes	-	Yes
36	Defense Innovation Unit (DIU) Investment	Yes	-	-
51	Domestic Content Restrictions	-	-	Yes
58	Hosting 5G Demonstrations	Yes	Yes	-
62	International Science and Technology Engagement	-	-	Yes
65	J-1 Visa Waivers	-	Yes	Yes
72	Multidisciplinary University Research Initiative (MURI) Investment	Yes	-	Yes

TABLE 3.8

Risks Associated with Approach Implementation

Approach Risks	Description and Examples
Technical Risks	"Risks that may prevent the end item from performing as intended or from meeting performance expectations. Technical risks can be internally or externally generated and may have cost, schedule, and/or performance consequences. They typically emanate from areas such as requirements, technology, engineering, integration, test, manufacturing, quality, logistics, system security, and training." Examples: R&D, prototyping, or validation failure; Valley of Death; scaling/follow-on costs.
Programmatic Risks	"Non-technical risks that are generally within the control or influence of the PM [program manager] or Program Executive Office (PEO). Programmatic risks can be associated with program estimating (including cost estimates, schedule estimates, staffing estimates, facility estimates, etc.), program planning, program execution, communications, and contract structure." Examples: over-/under-protection; lack of systematic evaluative mechanisms; reputation management; approach management complexity.
Business (External) Risks	"Non-technical risks that generally originate outside the program office, or are not within the control or influence of the PM. As appropriate, business risks should be escalated up the chain to the appropriate level. Business risks can come from areas such as program dependencies; resources (funding, schedule delivery requirements, people, facilities, suppliers, tools, etc.); priorities; regulations; stakeholders (user community, acquisition officials, etc.); market factors; and weather." Examples: negative public sentiment or other stakeholder scrutiny; lack of commercial market/relevance; depressed inbound foreign direct investment; depressed trade and foreign market opportunities; public disclosure—subject to adversary science & technology intelligence; interagency delay or disagreement; disputes or litigation.

SOURCE: DoD, 2017.

The Funding Appropriations comparison table shows type of funding appropriated by Congress for use of an investment approach (see Figure 3.12). Defense appropriation categories include Research, Development, Test, and Evaluation (RDT&E); Procurement; Operations and Maintenance (O&M); Military Personnel (MILPERS); and Military Construction (MILCON). Descriptions of each category can be found in Table 3.9.

The Precondition(s) to Use Approach comparison table shows any action(s) or condition(s) that must precede an approach's use (see Figure 3.13). The categories of preconditions that were screened were the requirement for an acquisition program, demonstrated lack of alternative funding, involve sensitive information, justified under national security interests, and justified according to foreign policy or internal obligation. Preconditions are necessary conditions that are exclusive of the approach but must be in place for the approach to be used.

FIGURE 3.12

An Example of a "Compare By" Table of Funding Appropriations

Approach Number	Approach Name	RDT&E	Procurement	O&M	MILPERS	MILCON	Nondefense
4	Export Controls (Commerce Control List)	-	-	-	-	-	-
6	Export Prohibitions (Lists of Parties of Concern)	-	-	-	-	-	-
7	Patenting	-	-	-	-	-	-
11	Intellectual Property Acquisition, Licensing, and Management	Yes	Yes	Yes	-	-	-
15	Industry & Academic Outreach and Coordination	Yes	-	-	-	-	-
20	Air Force Technology Transfer	Yes	-	-	-	-	-
22	Anti-Tamper and Technology Authentication	Yes	Yes	Yes	-	-	-
30	Program Protection	Yes	Yes	Yes	-	-	-
31	Critical Technology Protection	-	-	Yes	-	-	-
33	Defense Advanced Research Projects Agency (DARPA) Investment	Yes	-	-	-	-	-
36	Defense Innovation Unit (DIU) Investment	Yes	-	Yes	-	-	-
51	Domestic Content Restrictions	-	-	-	-	-	-
58	Hosting 5G Demonstrations	Yes	-	-	-	-	-
62	International Science and Technology Engagement	Yes	-	-	-	-	-
65	J-1 Visa Waivers	-	-	-	-	-	-

TABLE 3.9

Defense Appropriation Categories

Category	Description
RDT&E	"RDT&E appropriation accounts generally finance research, development, test, and evaluation efforts performed by contractors and government installations to develop equipment, material, or computer application software; its Development Test and Evaluation (DT&E); and its Initial Operational Test and Evaluation (IOT&E)."
Procurement	"Procurement appropriations are used to finance investment items and should cover all costs necessary to deliver a useful end item intended for operational use or inventory [e.g., shipbuilding and conversion, aircraft procurement, missile procurement]."
O&M	"O&M appropriations traditionally do not finance investments, but rather those things whose benefits are derived for a limited period of time, i.e., expenses."
MILPERS	"MILPERS appropriations are used to fund the costs of salaries and compensation for active military and National Guard personnel as well as personnel-related expenses . . ."
MILCON	"MILCON appropriation accounts . . . are enacted separately from the Defense Appropriations Act [and] fund the costs of major construction projects such as bases, facilities, military schools, etc."

SOURCE: DAU, undated.

FIGURE 3.13

An Example of a "Compare By" Table of Precondition(s) to Use Approach

Approach Number	Approach Name	Acquisition Program	Lack of Alternative Funding	Sensitive Information	Justification: National Security	Justification: Foreign Policy or International Obligation
4	Export Controls (Commerce Control List)	-	-	-	Yes	Yes
6	Export Prohibitions (Lists of Parties of Concern)	-	-	-	Yes	Yes
7	Patenting	-	-	-	-	-
11	Intellectual Property Acquisition, Licensing, and Management	Yes	-	-	-	-
15	Industry & Academic Outreach and Coordination	-	-	-	-	-
20	Air Force Technology Transfer	-	-	-	-	-
22	Anti-Tamper and Technology Authentication	-	-	Yes	-	-
30	Program Protection	Yes	-	Yes	-	-
31	Critical Technology Protection	-	-	Yes	Yes	-
33	Defense Advanced Research Projects Agency (DARPA) Investment	-	-	-	-	-
36	Defense Innovation Unit (DIU) Investment	-	-	-	-	-
51	Domestic Content Restrictions	-	-	-	Yes	-
58	Hosting 5G Demonstrations	-	-	-	-	-
62	International Science and Technology Engagement	-	-	-	Yes	Yes
65	J-1 Visa Waivers	-	-	-	Yes	Yes
72	Multidisciplinary University Research Initiative (MURI) Investment	-	Yes	-	-	-
73	Information Classification Determinations	-	-	Yes	Yes	Yes
74	National Security Innovation Capital (NSIC) Investment	-	Yes	-	-	-
76	Navy Technology Transfer (Navy T2)	-	-	-	-	-
80	Rapid Innovation Fund Investment	-	-	-	-	-
81	Rapid Reaction Technology Office (RRTO) Investment	Yes	Yes	-	-	-
91	Technology Release and Foreign Disclosure (TS&FD) Processes	Yes	-	-	Yes	Yes
118	Energy Infrastructure Loans and Loan Guarantees	-	Yes	-	-	-

Explore Why an Approach Is Included or Excluded

At the top of *Approach Results* worksheet is the navigation button for "Match Summary." Pressing it will navigate to a table that allow users to explore why a specific approach was filtered out of consideration (Figure 3.14). All approaches are listed in the table, including both those designated as "in" according to the selected inputs and those that were filtered out. Across the top of the table, there is a column for each input feature. If an approach is "in," then the word *match* will appear in every column for that approach. The approaches associ-

FIGURE 3.14

An Example of the Approach Matching Table

Approach Number	Approach Name	TRL	MRL	Sofware	Existing Applications	Dual Use	Strategy Objectives	Strategy COAs	Partners	Exclude Traditional Defense Contractor	Funding Source	Months	Features
11	Intellectual Property Acquisition, Licensing, and Management	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
51	Domestic Content Restrictions	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
166	Arms Exports (Conventional Arms Transfer)	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
446	Business Acceleration	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
T13	AF Ventures Investment	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
T14	AFWERX Prime Investment	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
T45	Manufacturing Technology Program Investment	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
T49	DoD Trusted Capital Investment	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
T53	Expansion of Productive Capacity and Supply (DPA Title III)	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
T95	Warstopper Program	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Match	Feature
4	Export Controls (Commerce Control List)	Match	Match	Match	Yes	Match	Match	Does Not Match	Match	Match	Match	Match	Feature
6	Export Prohibitions (Lists of Parties of Concern)	Match	Match	Match	Yes	Match	Match	Does Not Match	Match	Match	Match	Match	Feature
7	Patenting	Match	Match	Match	Yes	Match	Match	Does Not Match	Match	Match	Match	Match	Feature
15	Industry & Academic Outreach and Coordination	Match	Match	Match	Yes	Match	Match	Does Not Match	Match	Match	Match	Match	Feature
20	Air Force Technology Transfer	Match	Match	Match	Yes	Match	Match	Does Not Match	Match	Match	Match	Match	Feature
22	Anti-Tamper and Technology Authentication	Match	Match	Match	Match	Match	Match	Does Not Match	Match	Match	Match	Match	Feature

ated with a "do not match" for a specific feature column indicate the features for which a user input was not a match.

To consider why a specific approach was filtered out, locate the row corresponding to that approach and read across the table looking for the red highlighted cells that contain "does not match." The column name associated with that cell indicate a feature for which the user input did not match the characterization of that approach. Clicking on the "Feature" button at the end of an approach row will display another worksheet that provides a detailed view of how the approach was coded in the underlying database. An example of the Feature display is shown in Figure 3.15 for the Anti-Tamper approach. In our example, this approach did not match the user's input on COAs. Below you can see the set of COAs for which this approach was considered to be effective. The approach overview reports will provide detailed information for why each approach was coded the way it was in the original database.

Refining User Inputs

After exploring the relevant approaches, a user may choose to iteratively refine their inputs by navigating back from the *Approach Results* worksheet to the *P&P Inputs* worksheet. Each time new selections are made on the left side of this page, the *Approach Results*, *Match Summary* and *Comparison* tables are updated with the filtered in approaches.

Create User Report

Once the user is satisfied with the approaches selected by the tool, they can create a record of the inputs chosen and approach outputs. The user needs to have Adobe Acrobat Pro installed to create a report of their outputs. The *Approach Results* worksheet contains a "Create User Report" button. This button creates a PDF archiving the user's name, tool version, the inputs that were selected and the Approach Results table. A PDF of the user report will appear, and it can be saved in the same folder as the individual reports on relevant approaches.

FIGURE 3.15

Display of the Features Coded for a Specific Approach

Approach Number: 22   **Approach Name:** Anti-Tamper and Technology Authentication

What category does the approach map to?
Industrial security and acquisitions policy ▼

Who is permitted to be a partner for approach implementation?
☑ Qualified Small Business
☑ Startup/Venture Capital
☑ Consortium
☑ Academia
☑ Federal, SLTT
☑ Other defense contractors (traditional and non-traditional)

☐ **Exclude traditional defense contractors?**

What objectives does the approach try to fullfill?
☐ Promotion: Technology innovation and development
☐ Promotion: Industrial base manufacturing and capability
☑ Protection: Technology and industrial base

How does the approach achieve it's objective (i.e., using which courses of actions)?

☐ Foster a new or emerging technology, service, or process
☐ Mature a new or emerging technology, service, or process into development
☐ Improve manufacturing, e.g. remove inefficiencies
☐ Preserve/expand industrial base, e.g. increase manufacturing capacity
☐ Tap commercial capability for government/defense purposes, e.g. incentivize production priorities
☐ Diversify and strengthen the supplier base
☐ Leverage international research and development capabilities

☐ Retain access to critical suppliers (from loss, sale, or merger and acquistion)
☐ Transfer government developed technology to the commercial sector
☐ Understand the scale and composition of supplier base
☐ Understand the supplier's financial market
☐ Understand sub-contractor suppliers for a program
☐ Develop and sustain the workforce
☑ Leverage contractual requirements (i.e. for technology protection)

☐ Manage Foreign Ownership, Control, or Influence (FOCI)
☑ Limit foreign access to critical technology
☐ Assure USG access to strategic materials
☑ Secure critical information and technologies in the supply chain
☑ Protect critical information and technologies from cyber threats
☑ International actions to maintain national competitiveness

Select all of the entering TRLs the approach will accepts?
☑ 1 ☑ 2 ☑ 3 ☑ 4 ☑ 5 ☑ 6 ☑ 7 ☑ 8 ☑ 9

Select all of the entering MRLs the approach will accepts?
☑ 1 ☑ 2 ☑ 3 ☑ 4 ☑ 5 ☑ 6 ☑ 7 ☑ 8 ☑ 9 ☑ 10

☐ **Is the approach exclusively used for software?**

☐ **Is the approach funded by direct expenditures?**

If funded by direct expenditures, what source(s) of funds can it accept?
☐ Within OSD
☐ Other DoD Component
☐ Industry
☐ Other government

For which types of applications is the approach applicable?
☑ Commercial/industry
☑ Defense
☑ Nondefense government
☑ Dual-Use
☐ No existing applications

If the approach is applicable to dual-use applications, which market must dominate?
☐ Commercial/industry
☑ Defense
☐ Nondefense government
☐ No U.S. market dominates

In which months can requests be placed for the approach?
☑ January   ☑ July
☑ February   ☑ August
☑ March   ☑ September
☑ April   ☑ October
☑ May   ☑ November
☑ June   ☑ December

Close

Administrator Interface

The Administrator Interface is an Excel workbook enabled with macros using Visual Basic for Applications (VBA), which can be used to create a User Tool for distribution. Unlike the user version, the Administrator Interface can be used to add a new approach, edit the coding for an approach, delete an approach, upload or update an overview report for an approach, and control the version of the database of approaches. This file does not need to be sent out with the user tool. Only administrators who can change or add to the database of approaches should have access to this file.

First Use of the Administrator Interface

The Administrator Interface must be used to update any user version of the tool that is generated after the database of approaches is updated or modified. It is only compatible with a PC system and cannot be used on mobile devices. Copy the zipped folder containing the administrator interface, user tool template, and all the approach overview files tool to a local hard drive and then extract all files from the zipped folder into a single folder on the hard drive. The files must be located in the same folder for the tool to function. *Critically, the names of the "Admin-Tool" and the "User-Tool-Template" files should not be changed or updated.* These files form the basis for all future updates. Unlike the user tools, the cells and sheets in the Admin Interface are unlocked. Moving cells, or adding or deleting rows, will "break" the coding of this Excel tool. Using the forms to change and edit context will ensure the tool remains functional.

Go to the Excel file named "Admin-Tool" and open the file. The user tool uses VBA coded macros that need to be enabled on first use. When opening the Admin Tool, Excel presents the following security warning in a yellow banner below the "ribbon." Click "Enable Content" to ensure that the Interface can run by accessing its built-in macros.
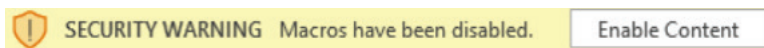
It is important to note that use of the Administrator Interface limits the functionality of any other Excel workbook open locally. All other Excel workbooks should be closed while the interface is being used.

Creating a User Tool

The Administrator Interface (see Figure 4.1) is used to generate the database of approaches for the P&P User Tool. To properly track use of both tools, the Administrator Interface has been enabled with the following functionality:

- *A worksheet to log modifications to the database of approaches.* The Administrator Interface includes a *Modification Log* worksheet. Each time a change is made to the database of approaches, an entry should be made in the log to keep a record of the version of the database and the changes to the data associated with them.
- *The ability to change the approach database's version number.* The administrator can determine the version number of the approach database by changing the version number in the Administrator Interface. Clicking "Update Data Version" allows the administrator to change the number associated with the current version of the approach database. The version number should be adjusted or increased every time a change is made to the underlying database. The new version number will be displayed on the *README* tab of the Administrator Interface and any cloned User Tool created subsequently.
- *A worksheet to log changes.* The Administrator Interface includes a *Use History* worksheet. Each time a new data tab is generated and distributed to a user, an entry should be made in the log to keep a record of the version of the database used in that specific instance of the tool and for which user it was intended.

FIGURE 4.1

Screen Shot of Administrator Interface Worksheet
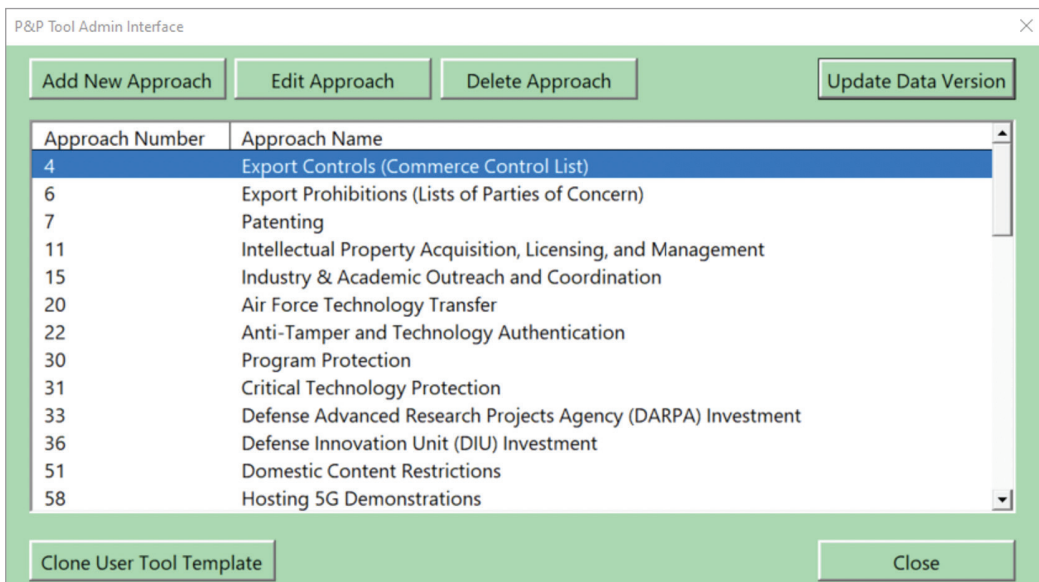
Creating an updated P&P User Tool with the most current approach database is done by clicking the "Clone User Tool Template" button on the Admin Interface form (Figure 4.1). An updated Excel workbook will be named and should be saved in the same folder as the "reports" folder. Creation of a cloned user template should be recorded in the *Use History* log. To share a User Tool—without the administrator functions—create a folder with the most recent cloned user tool and the "reports" folder containing all the approach overviews in PDFs. Compress that folder using the zip files feature and email the zipped folder to the new user. That user can follow the instructions in Chapter Three for use of the tool.

Adding an Approach

Adding a new approach to the database is done by clicking the "Show Admin Interface" button on the *README* worksheet, and the "Add New Approach" button on the open form. The administrator will be asked to name the new approach and a new tab for adding the approach, "Add New Approach," will be opened (see Figure 4.2). Newly added approaches are given a number starting with 1000 (then 1001, etc.) so that they can be identified separately from the original set of approaches listed in Appendix C. Note that the administrator should log the change to the database in the *Modification Log* and change the database version number.

Adding the new approach involves coding the approach for all the features that are used for inputs, outputs, and comparisons as described in the User Manual in Chapter Three. The form that opens when the "Add New Approach" contains three tabs that should be populated with information about the new approaches: *Approach Inputs*, *Approach Outputs*, and *Approach Information*. The way to code the *Approach Inputs* for a new approach is described here in detail.

Technology Strategy Features

The first set of approach features are about the strategy aims and objectives that the approach could impact. This section includes the following questions:

- *Which objectives does the approach try to fulfill?* Adding an approach requires consideration of what the approach might be expected to do in terms of strategy. The strategies are framed at a high level, categorized as Promote Technology, Promote the Industrial Base, or Protect Technology and Industrial Base (see Table 4.1). Each objective that the approach can fulfill should be checked.
- *Who is permitted to be a partner for approach implementation?* All the potential types of organizations that the government could partner with to implement the approach should be selected under acceptable partners (see Table 4.2). Indicate whether partners must be non-traditional defense contractors.

FIGURE 4.2
Screen Shot of Worksheet to Add an Approach

- *How does the approach achieve its objective (i.e., using courses of action)*? COAs are meant to identify all the potential ways that the approach could be expected to achieve its objectives (see Table 4.3). Note that each approach is expected to be associated with a few COAs that it can influence.

TABLE 4.1

Strategy Objectives

Strategy Objective Choices	Definition and Examples
Promotion: Technology innovation and development	Improvements needed to identify, create, or advance new technology (e.g., innovation programs, R&D, prototyping, development of derivative applications of commercial sources).
Promotion: Industrial base manufacturing and capability	Improvements needed to strengthen defense industrial base manufacturing and capability (e.g., Human Capital Development, Capacity, Demand/Supply, Diminished Manufacturing Sources [DMS])
Protection: Technology and industrial base	Improvements needed to mitigate adversary threats to the technology and industrial base (e.g., "operations security, information safeguarding, research protection, designed-in system protections, SCRM [supply chain risk management], software assurance, hardware assurance, anti-counterfeit practices, AT [Anti-Tamper], and program security related and engineering cyber-resilient activities" (DoDI 5000.83, 2021, p. 13)

TABLE 4.2

Acceptable Partners

Acceptable Partner Choices	Definition and Examples
Qualified small business	Registered business that qualifies as a small business under Small Business Administration basic requirements based on size and sector standards (SBA, undated)
Startup/venture capital	Newly developed and typically privately held companies, often prior to production of a specific product or technology. Venture Capital refers to private equity investment organizations or individuals that seed startup companies.
Consortium	Coordinated group of member companies, which may include some academic, nonprofit, or trade organizations
Academia	Universities and other nonprofit research organizations including federally funded research and development centers (FFRDCs) and some national laboratories
Federal, SLTT	Any part of federal, state, local, tribal, or territorial governments
Other defense contractor	Other non-specified partners, including but not limited to traditional and non-traditional defense contractors
Non-traditional	If the partner is known to be limited to non-traditional defense contractors, then "yes" should be checked to limit approaches to those that utilize the subset that uses partner status as a criterion.

TABLE 4.3

Strategy Courses of Action

Strategy COA Choices	Definition and Examples
Foster a new or emerging technology, service, or process	Provide direct early support to C&ET R&D (e.g., via investment in R&D, partnering, academic engagement).
Mature a new or emerging technology, service, or process into development	Provide direct support to bridge the "valley of death" (e.g., through prototyping, experimentation, testing, evaluation).
Improve manufacturing, e.g., remove inefficiencies	Reduce manufacturing risks and promote innovative manufacturing processes and methodologies (e.g., advanced manufacturing technologies and techniques).
Preserve/expand industrial base, e.g., increase manufacturing capacity	Preserve or expand critical defense industrial capacity at an affordable price (e.g., via investment in property, plant, and equipment; government acquisition of IP).
Tap commercial capability for government/defense purposes, e.g., incentivize production priorities	Benefit from the technological innovations available from a larger industrial base/commercial market (e.g., using commercial off-the-shelf [COTS] products and services; eliminating business practices that drive unnecessary defense-unique capabilities; tapping the global commercial market; outreach to non-traditional vendors).
Diversify and strengthen the supplier base	Ensure the supplier base is robust, secure, and diverse (e.g., through U.S. government sales, Foreign Military Sales [FMS]/Direct Commercial Sales [DCS], Foreign Military Financing [FMF], foreign and allied sustainment and parts contracts and sales, other commercial markets, foreign manufacturing and assembly agreements, recovery of costs through sale of surplus and obsolete materiel).
Leverage international R&D capabilities	Leverage international innovation and research capabilities (e.g., through information and personnel exchange, foreign testing, and exercises, jointly funded R&D).
Retain access to critical suppliers (from loss, sale, or merger and acquisition)	Plan and leverage contingencies for the loss or sale of sole, key, or unique suppliers (e.g., through government investment in existing suppliers; M&A review; government ownership; including costs of supplier preservation in budgets, acquisition plans, and resource allocations; Build Back Better).
Transfer government developed technology to the commercial sector	Provide return to taxpayer for government investment (e.g., through technology transfer; technology transition; IP licensing and management).
Understand the scale and composition of supplier base	Maintain comprehensive understanding of the actual and potential supplier base (e.g., number, location, and ownership of suppliers).
Understand the supplier's financial market	Maintain knowledge of the relevant venture and investment aspects that might affect suppliers (e.g., economic and financial forces; fragility of suppliers; ties to other investments).

Table 4.3—continued

Strategy COA Choices	Definition and Examples
Understand subcontractor suppliers for a program	Maintain and validate program-level supply information (e.g., verification of bill of materials [BOM] data; transparent use of approved vendors list [AVL]; comprehensive and accurate supplier data, including Federal Procurement Data System–Next Generation [FPDS-NG], SAM.gov, industry databases such as the ERAI counterfeit electronics database and the UK's ESCO Council forum on counterfeit parts, government databases such as the Government Industry Data Exchange Program [GIDEP], national and international legal data such as court records, and supplier-specific records such as Juran's scorecard).
Develop and sustain the workforce	Develop and maintain a workforce that meets or exceeds labor market demands and security standards (e.g., through technical, scientific, and manufacturing education and training; personnel security, information security, and counterintelligence standards).
Leverage contractual requirements (i.e., for technology protection)	Ensure comprehensive compliance, including contractually, with all appropriate regulations and standards (e.g., Federal Acquisition Regulation [FAR], Defense Federal Acquisition Regulation Supplement [DFARS], National Institute of Standards and Technology Special Publication [NIST SP] 800).
Manage Foreign Ownership, Control, or Influence (FOCI)	Understand, document, and mitigate national security risks arising from foreign influence and networks (e.g., knowledge of ownership of domestic suppliers, knowledge of foreign suppliers, foreign investment review/ Committee on Foreign Investment in the United States [CFIUS], compliance with Trade Agreements Act [TAA]).
Limit foreign access to critical technology	Regulate the export of C&ET articles and services to prevent acquisition by strategic competitors (e.g., through International Traffic in Arms Regulations [ITAR]/ Export Administration Regulations [EAR]; multilateral export control regimes; IP protections).
Assure U.S. government access to strategic materials	Maintain knowledge of strategic materials provenance and supply chain (e.g., foreign suppliers; foreign ownership or influence of domestic suppliers of strategic materials; conflict materials).
Secure critical information and technologies in the supply chain	Consistently and appropriately use supply chain controls inspections, and testing (e.g., National Industrial Security Program Operating Manual [NISPOM], Department of Defense Manual [DoDM] 5220.22, Executive Order [EO] 12829); anti-tamper technology; counterfeit detection, identification, and removal methodologies: monitoring the supply network, tracking supply chain deviations through intelligence and financial data).
Protect critical information and technologies from cyber threats	Ensure that National Security Innovation Base (NSIB) entities implement appropriate cybersecurity practices and processes and maintain knowledge and understanding of the software/cyber issues in the supply chain (e.g., by proper classification of IP; use of industry standard secure development practices; knowledge of code provenance, authorship, and supply chain vulnerabilities).
International actions to maintain national competitiveness	Maintain technological advantage vis-à-vis adversaries (e.g., export; sales; ownership/control; sources).

Technology Features

The approach should be coded for a second set of features related to the current state of the specific technology under consideration. This section contains the following prompts and questions:

- *Select all the entering TRLs the approach will accept.* The TRL specifies the maturity of the technology that would be relevant to use the approach. Definitions for each TRL are detailed in Table 4.4 from GAO's *Technology Readiness Assessment Guide* (GAO, 2020). If the approach is not relevant to a specific technology readiness level, then all TRLs can be selected.
- *Select all of the entering MRLs the approach will accept.* The MRL allows specification of the manufacturing level that is relevant for the approach. If the approach is not relevant to a specific manufacturing readiness level, then all MRLs can be selected. Definitions for each MRL are detailed in Table 4.5 from the OSD Manufacturing Technology Program's 2020 *Manufacturing Readiness Level (MRL) Deskbook* (OSD, 2020).
- *What category does the approach map to?* A drop-down menu on the page allows the new approach to be put into one of the following categories from Table 4.6. The category is intended to reflect the intended action or activities that the approach takes. Each approach is associated with only one category.
- *Is the approach exclusively used for software?* A characteristic of the approach asks whether the approach is exclusively used for software. If "yes" is checked, then that approach will only be considered when the technology use is software. Note that most approaches apply both to software and non-software technology applications. In this case, the approach should be coded "no" because it is not exclusively applied to software.
- *For which types of applications is the approach applicable?* This approach characteristics relates to the current market for applications of the technology that would be relevant. The administrator should indicate the type(s) of technology end use for which the approach could be used. Note, for example, that Defense Innovation Unit (DIU) Investment targets commercial technologies for development of novel military applications. The values that can be selected are commercial/industry, defense, nondefense government, dual-use, and no existing applications. The current applications could include multiple of these options; an approach might accept a technology with defense, dual-use, and commercial/industry applications. All appropriate and known applications should be selected for the approach.
- *If the approach is applicable to dual-use applications, which market must dominate?* If the approach can be applied to dual-use technology, then an indication should be made about which market concentrations would be applicable for use of the approach. If the majority of demand for the dual-use technology is located in any of the following markets, does the approach still apply? The values that can be selected are N/A or unknown, commercial/industry, defense, nondefense government, and no U.S. market dominates.

TABLE 4.4

Definitions of Each TRL from GAO's *Technology Readiness Assessment Guide*

TRL	Description
1. Basic principles observed and reported	Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in a laboratory environment	Basic technological components are integrated to establish that they will work together. This is relatively low fidelity compared with the eventual system. Examples include integration of ad hoc hardware in the laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include high-fidelity laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7. System prototype demonstration in an operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring the demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).
8. Actual system is completed and qualified by test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of the true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational conditions.

SOURCE: Reprinted verbatim from GAO, 2020, p. 11.

TABLE 4.5
Manufacturing Readiness Level Descriptions

MRL	Definition
1	Basic manufacturing implications identified
2	Manufacturing concepts identified
3	Manufacturing proof-of-concept identified
4	Capability to produce the technology prototype components in a laboratory environment
5	Capability to produce the technology prototype components in a production relevant environment
6	Capability to produce a prototype system or subsystem in a production relevant environment
7	Capability to produce systems, subsystems, or components in a production representative environment
8	Pilot line capability demonstrated; ready to begin Low Rate Initial Production (LRIP)
9	Low rate production demonstrated; capability in place to begin Full Rate Production (FRP)
10	Full rate production demonstrated and lean production practices in place

SOURCE: Office of the Secretary of Defense Manufacturing Technology Program, 2020.

Acceptable Conditions Features

Another set of approach features is the conditions or constraints relating to the use of the approach. Two features should be specified: the types of funding arrangements and the acceptable months to place requests.

- *Is the approach funded by direct expenditures?* The first feature considers whether the approach requires funding direct expenditures and is an investment approach.
- *If funded by direct expenditures, what source(s) of funds can it accept?* If the former question is checked with a "yes," all the potential options for funding sources should be identified. The options for investment sources include within OSD, from another DoD component, from industry, or from another government source outside DoD. All possible funding sources should be selected.
- *In which months can requests be placed for the approach?* The second approach feature requires the selection of all months that are possible to place requests for initiation of the approach. If the approach can be initiated at any time, then all months should be checked.

TABLE 4.6

Approach Categories and Definitions

Category	Definition	Approach Example
Developed shared enterprise with industry	A partnership between public and private sectors pooling resources to develop an end product that benefits all parties	Public-private partnerships (PPPs)
Innovation and research investment	Direct financial investment in innovation or research that will require further development including prototyping and operationalizing	Defense Advanced Research Projects Agency (DARPA), Defense Innovation Unit
Industrial security and acquisitions policy	Processes and procedures to gain access to, handle, or generate secure information or to make acquisitions appraisals and decisions	PPPs, Changes to FAR
Policies and standards for intellectual property and data access	Policies and procedures surrounding DoD access to information required for modification of technology products or data	Patenting
International cooperation and agreements (non-investment)	Instruments for the management of interactions between states and other subjects of international law	International treaties
Non-investment support of commercial or academic programs	Support of consortia, academic, or commercial enterprise without an associated acquisition	Outreach, Business development
Technology procurement and purchasing	Purchase of technologies or services by DoD or other authorized entities	Conventional Arms Transfer
Capital investment and Financing	Supporting the access of a commercial entity to research, innovation, and production inputs	ManTech, DPA Title III
Review of companies, investments, and M&A	Government review of private organizations, their activities, supply chains, as well as M&A	Committee on Foreign Investment in the United States (CFIUS), Trusted capital
Review or limit technology distribution	Programs and processes designed to restrict technology distribution, or identify technologies for future restricted distribution	Export controls
Workforce-related programs	Programs that aim to expand, diversify, or regulate the workforce	Registered apprenticeship program

Approach Outputs

Several other fields are included under the *Approach Outputs* tab that are used to represent the new approach in the Results Table of the User Tool:

- *Who is the lead program?* The "Lead Program" box should reflect the entity that administers/executes the new approach; the field values for this category are OSD, Air Force, Army, Navy, DoD agency, non-DoD federal agency, SLTT (state, local, tribal, or territorial), and Other.
- *Which organizations have related programs?* A box that informs "Other services with Equivalent Approaches" asks "Which organizations have related programs?" If there is a related program with some/all branches of the services, the corresponding boxes should be checked.
- *Does the approach require congressional action?* The "Congressional Action Required" box should be marked to reflect whether congressional action must precede/authorize the execution of an approach.
- *Which type of funding appropriation can be accepted by the approach?* Defense appropriation categories include Research, Development, Test, and Evaluation (RDT&E); Procurement; Operations and Maintenance (O&M); Military Personnel (MILPERS); and Military Construction (MILCON).
- *What are the stated or inferred preconditions for using the approach?* The categories of preconditions that should be considered for the new approach are the requirement for an acquisition program, demonstrated lack of alternative funding, involvement of sensitive information, justification under national security interests, and justification according to foreign policy or internal obligation. If any of these are necessary conditions that must be in place for the approach to be used, they should be identified in this section.
- *What is the investment size of the approach?* An "Investment Size" input should be used to track the average amount (or range) of funding per project supported by the new approach. Non-investment approaches are coded as "Not Applicable."

Approach Information

Additional text fields associated with the "Add New Approach" input form (see Figure 4.2) are under the *Approach Information* tab. These are features displayed as outputs or brief narratives that describe the approach. None of these output features impact the ability of a user to filter or select approaches. The text fields are displayed when the user presses the "Info" button for the approach on the *Approach Results* worksheet of the User Tool.

The "Summary" field is also exhibited in the approach list on the *P&P Inputs* worksheet. The specific office that administers the approach should be entered under Office. Three text fields are listed for up to three websites associated with the approach. Other descriptions that can be added are about the range of potential sources of funding. The Color of Money field should reflect whether the approach needs RDT&E, Procurement, O&S, MILCON, MILPERS,

or Nondefense, and this field may be used to indicate a particular budget activity (e.g., 6.3, 6.4). The Process Requirements field should be populated with the specific conditions or requirements that are necessary for the approach to be used. The Process Timeframe should contain the steps involved in executing the approach and how long each step is expected to take. The Expected Outcome or Effect should describe the products or change intended from the implementation of the approach; this description is expected to relate the approach to the COAs that have been paired with it. The Limits and Downsides should reflect notable limits and potential downsides of promoting or protecting critical and emerging technology using the approach. The remaining fields may be used to identify Key References (e.g., user guidance, frequently asked questions, statutes, DoD issuances) and programs that may be clearly related to the approach.

Other Administrator Functions

In addition to adding an approach, the Administrator Interface (Figure 4.1) provides for three additional administrator functions.

- *Edit data for an approach.* Select an approach from the drop-down list and click the "Edit" button. A pre-filled form will appear for that approach that looks identical to that for adding a new approach (Figure 4.2). The existing coding and text fields associated with that approach will be populated in the worksheet. Any of the coding for the approach features can be edited following the process described above.
- *Delete an approach.* Deleting an approach is as easy as selecting its name from the list of approaches. Note that administrator should log the change to the database and resave the Administrator Interface file with a new version number when an approach is deleted.
- *Upload/Update a report for an approach.* While editing or creating an approach, a report for a new or edited approach can be added to the databases. A supplemental report for an approach can be uploaded or replaced (in PDF format). The file will be renamed according to the approach name and saved to the "report" folder that allows users to access it with the "Overview" button in the P&P User Tool.

Conclusion

This report provides supporting documentation for a tool to assist DoD in the identification of government approaches to support promotion or protection of a technology. The tool and its underlying selection framework are intended for use by government entities to inform decisionmaking about the approaches relevant for specific technology problems of interest. In addition to describing the tool's underlying framework, this report provides two user manuals. The first is for the User Tool, which walks a user through a process of inputting pertinent information and exploring a list of potentially relevant approaches with additional comparative information. The second manual details the function of the Administrator Interface, which can be used to add, remove, or edit the information related to the approaches contained in the database. The Administrator Interface is used to generate new versions of the database of approaches that can be cloned into new versions of the User Tool template.

The first version of the P&P Tool contains data for 35 approaches that were characterized as a part of this project. However, this is a small subset of the available approaches that could be included in the tool; as part of the original effort, we identified approximately 192 approaches that may be applicable for inclusion. The methodology for how we identified, researched, and coded approaches is detailed in Appendix A. The full list of identified approaches are listed in Appendix C. Overviews of the 35 approaches that were selected for inclusion are embedded in the User Tool. A guide to the contents of these overviews can be found in Appendix E.

DoD Outcomes from Tool Use

The use of the P&P Tool provides two types of value for government users. First, it allows rapid identification of approaches that are relevant for a specific use case or technology strategy. The tool provides a direct comparison of all the approaches identified as relevant and links to details about their requirements. The database of approaches is also a good source of information to determine why a specific approach of interest is not relevant. Considering why specific approaches do not match the user's inputs may provide opportunities to change or challenge the framing of the chosen strategy for a critical technology. Occasionally, the tool may indicate that no approach in the database is relevant for a specific use case. When the set of approaches contained in the tool is considered to represent the breadth of government

options, the lack of identified approaches could be a signal that new mechanisms are needed for technology protection and promotion in a specific area or sector.

The database of approaches contained in the tool, and the research on those approaches, provides additional value as a decision aid. Detailed overviews on each approach describe their expected outcomes as cataloged in the approach database. Research on approaches that are implemented outside of DoD may be particularly informative for users who are less familiar with those programs. These include

- The U.S. Department of Labor's Registered Apprenticeship Programs (RAP) talent development programs for the skilled trades (including cyber and semiconductor manufacturing) applied to by employer of employee resource group.
- The U.S. Department of Energy's Loan Program from the 2005 Energy Policy Act (Title 17) provides capital for advanced technology including critical minerals, supply chain issues, electric vehicle battery manufacturing, and energy storage and transmission.
- The U.S. Department of Homeland Security's Customs and Border Patrol trade protection/anti-counterfeit program uses distributed ledger technology and standards-setting for supply chain transparency and IP verification. Near real-time data may be available to DoD through the Border Interagency Executive Council (BIEC). The U.S. Department of the Treasury's Office of Tax Analysis's research on Research & Experimentation (R&E) Tax Credits indicates that the credits encourage R&D in the United States.

Next Steps

Additional opportunity exists to expand the number and types of users for this tool, as well as to increase the tool's utility for all users. These additional efforts are appropriate next steps for this project.

The range of interested organizations who may benefit from using the framework tool extends across DoD, as well as other parts of the U.S. government. Exploring the spectrum of potential users and reviewing the tool with them would allow the specification of the needs for a set of users. Discussions with a range of potential users would allow the collection of additional information about their decision needs, the usability of the current tool information, and the value of converting the Excel VBA tool to a different software platform (e.g., web-maintained rShiny or Python).

Expanding the number and diversity of approaches that are available in the tool provides an opportunity to better represent the full range of potential government activities and to provide decision-relevant approach information to a range of users. The selection of approaches to include should reflect the interests and needs of the tool's users. Researching and characterizing more approaches for inclusion in the tool should follow or accompany the exploration of the needs of users described above. Once an appropriate set of approaches is selected, data collection for additional approaches (and to fill in any information gaps of existing approaches) could be streamlined through the development and distribution of a

fillable approach data collection form to the lead agency for each approach. For this version of the Protect and Promote tool, we do not anticipate that novel features describing the approaches will need to be added or that there will be a need to change the logic for filtering the features. Follow-up discussions with the approach owners would be necessary to improve the collection form and to check to ensure it is effective for the diversity of approaches.

Methodology

This appendix describes the research methods we used to identify and characterize promotion and protection approaches. We relied extensively on the background material, publicly available documentation, subject-matter experts (SMEs), and discussion with the programs and offices that implement the identified approaches. Research proceeded as follows:

1. Identify the universe of potential approaches through a review of the literature.
2. Prioritize approaches for further analysis.
3. Describe approaches through desk research and semi-structured discussion with SMEs.
4. Characterize approaches for tool inclusion through analysis.

Literature Review

We scoped the literature review and began identifying potential approaches based on a set of 16 approaches characterized as core mechanisms for technology protection and promotion. The original set was developed into a list of 41 based on knowledge of additional relevant approaches.

We proceeded by searching publicly available literature, using Google advanced site search, to find materials that identify approaches available to federal departments or agencies. We included U.S. government websites and material relevant to promoting the NSIB and protecting the U.S. technology advantage, broadly construed. We considered all policy instruments—the set of ways and means available to DoD components and their partners—to implement national technology promotion and protection. For the purposes of this review, policy instruments include specific approaches, the institutions and organizations directly responsible for them, and the authorities upon which these institutions and organizations operate. We excluded materials that focused exclusively on retrospective protection approaches.[1]

---

[1] Retrospective protection approaches are those initiated after a specific technology loss has occurred, such as federal prosecutions, and are beyond the scope of this project.

To determine search terms for identifying additional approaches, we reviewed the 16 approaches STP&E identified and the 41 approaches our project team identified. We also reviewed DoD Instruction 5000.83, *Technology and Program Protection to Maintain Technological Advantage* (DoDI 5000.83, 2021), *DOD Critical Technologies: Plans for Communicating, Assessing, and Overseeing Protection Efforts Should Be Completed* (GAO, 2021), example scenarios that STP&E provided, and the project description. Using Google advanced site search, we first tested the search terms *protect*, *promote*, *technology*, *research*, *development*, *manufacturing*, *innovation*, *defense*, and *security*. After testing various combinations for relevance, we conducted a search using the combined search terms *protect* OR *promote* AND *technology* AND *manufacturing* AND *defense* for each agency website (example: "site:state. gov protect technology manufacturing defense").

During March 2021, we applied this method to search for additional potential approaches on the websites of ten government agencies: DoD (including the entire STP&E website), the Department of Commerce, the Department of Energy, the Department of Homeland Security, the Department of Justice, the Department of Labor, the Department of State, the Department of the Treasury, the Office of the Director of National Intelligence, and the Small Business Administration. We also carried out a "snowball" search to identify additional approaches by searching links and reference lists of documents published on the agency websites. We used this snowball method to identify approaches from additional DoD components (such as the military departments and defense agencies), other federal bodies (such as the Executive Office of the President and Congress), as well as international and nongovernmental bodies (such as the North Atlantic Treaty Organization and the World Trade Organization).

The initial search resulted in 103,869 total records (internet links), of which a subset of 379 publications (webpages and documents) were included to identify and characterize potential approaches (see Figure A.1). Google automation excluded 100,865 records for similarity. We screened the remaining 2,815 records by title and description, excluding records that identified inactive approaches or material otherwise irrelevant to technology promotion or protection. This resulted in 379 publications for review.

We divided the 379 publications among three researchers for independent review, based on each researcher's familiarity with each source. One researcher reviewed DoD content; another reviewed Department of Labor, Department of State, Department of the Treasury, Office of the Director of National Intelligence, Small Business Administration, and other federal, international, and nongovernmental content; and the third reviewed Department of Commerce, Department of Energy, Department of Homeland Security, and Department of Justice content. Each researcher populated a spreadsheet with approaches identified during their review, recording, at a minimum, the approach name, key agencies/entities involved in administering the approach, and a brief description of the approach's purpose and function.[2]

---

[2]   In most cases, the approach name is derived from a specific U.S. government program, project, or activity (e.g., DARPA investment). When an approach does not explicitly involve a specific program, project, or activity, we assigned a brief, descriptive approach name (e.g., "Business Acceleration").

FIGURE A.1

Publication Search Strategy, Selection Process, and Results
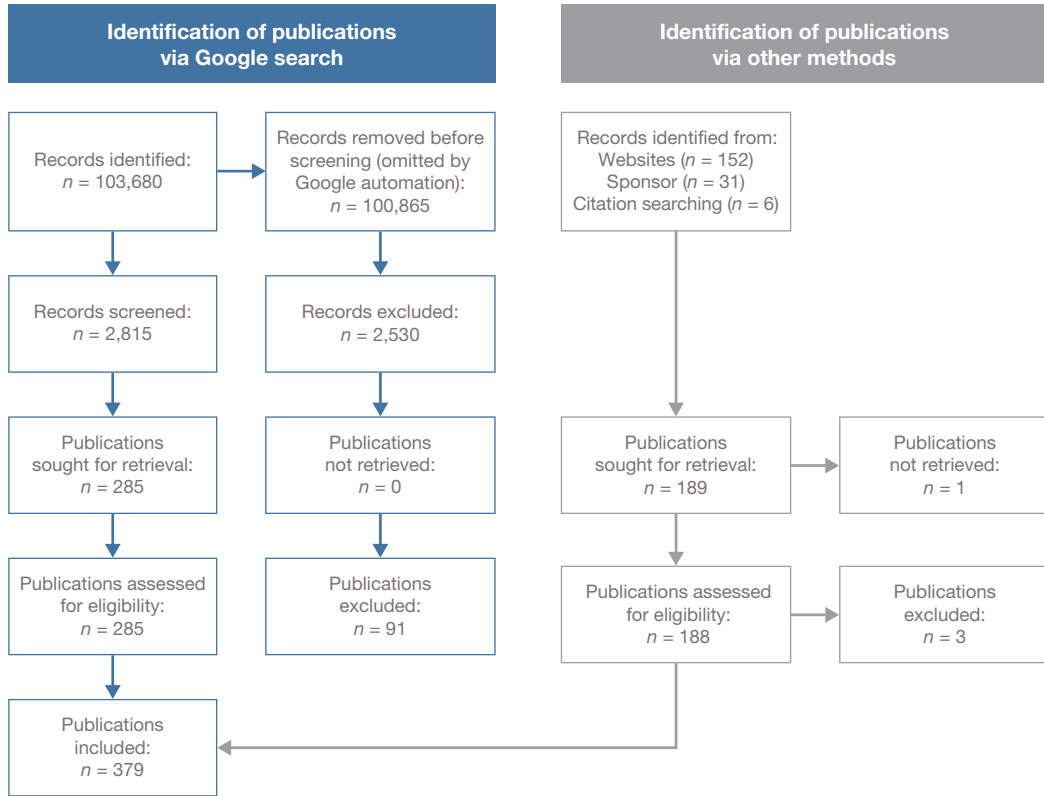
SOURCE: Adapted from PRISMA Flow Diagram (Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA], undated).

We identified a total of 268 approaches through this first search round. To ensure as exhaustive a search as possible, we followed with a second round using more inclusive search criteria, specifying *protect* OR *promote* AND *technology*. Through this second search round, one researcher identified 65 additional potential approaches. During subsequent data collection and analysis, we identified an additional five potential approaches. In total, this process identified 338 potential approaches.

Three sources of bias limit our ability to identify the entire universe of potential approaches available to the U.S. government: publication bias, data availability bias, and selection bias. Google indexing and automation operate as publication bias, limiting our data sources to webpages and documents displayed as search results. Data availability bias occurs if information about a potential approach is not publicly available online. Our choice of search terms and data sources may have resulted in selection bias. Selection bias occurs when the set of observations examined does not reflect the entire universe of observations. We addressed these sources of bias by (1) ensuring that we provided STP&E an actionable, comprehensive

set of approaches and (2) validating that our results spanned all major categories of approach derived from the relevant literature. For the first aim, we consulted with STP&E to ensure data availability bias did not result in excluding desired approaches. For the second aim, we addressed publication and selection biases through the following steps:

1. Testing the application and distribution of approaches within the 22 actions listed in the National Strategy for Critical and Emerging Technologies (The White House, 2020).
2. Aligning approaches to the literature on science, technology, and innovation (STI) policy, including STI policy instrument categories promulgated by the Organisation for Economic Co-operation and Development (2021) and the United Nations Economic, Scientific and Cultural Organization (2021).
3. Deriving from the STI literature a comprehensive, mutually exclusive set of 11 approach categories, to which we assigned each approach in the P&P Tool (see Table A.1).

TABLE A.1
Summary of Approach Categories

Category	Example	# of Approaches Included[a]
Develop shared enterprise with industry	Technology transfer	3
Innovation and research investment	DARPA investment	8
Industrial security and acquisitions policy	Defense Counterintelligence and Security Agency (DCSA) Critical Technology Protection	7
Policies and standards for intellectual property and data access	IP acquisition, licensing, and management	2
International cooperation and agreements (non-investment)	Import actions (Section 232 Investigation)	2
Non-investment support of commercial or academic programs	Business acceleration	3
Technology procurement and purchasing	Arms exports	1
Capital investment and financing	Small Business Investment Company (SBIC) Program investment	2
Review of companies, investments, and M&A	Committee on Foreign Investment in the United States (CFIUS) review	0[b]
Review or limit technology distribution	Export controls	2
Workforce-related programs	Registered Apprenticeship Program occupational training	5

[a] Only the 35 approaches reviewed by RAND and included in the final P&P Tool were coded and validated by approach category.

[b] CFIUS is listed as an example, but not included in the final set of approaches coded and validated by RAND.

Prioritization of Approaches for Further Analysis

We adjudicated each of the 268 approaches identified during the first search, by evaluating whether they met our working definition of an approach and ensuring none were duplicated. Recall that three researchers independently identified subsets of the 268 approaches. Subsequently, a separate researcher reviewed each researcher's findings to establish consensus on inclusion. In case of disagreement or uncertainty, a third researcher was consulted to make the final determination. Of these, we selected 192 unduplicated approaches for inclusion. Included approaches were found by consensus to meet the definition of "an action or process that DoD can take to influence other agents' decision-making [and that] connects the objectives expressed in the *National Strategy for Critical and Emerging Technologies* (The White House, 2020) with intended effect(s) on the NSIB." Duplicated approaches were those cross-listed by multiple agencies or bodies and were de-duplicated by identifying a single agency with primary responsibility for administering the approach. The additional potential approaches identified during the second search round, data collection, and data analysis were not authenticated at this stage.

We then consulted with STP&E to narrow the set of approaches for further analysis and ultimate inclusion in the P&P Tool. STP&E reviewed the list of 192 unduplicated approaches, assigning each a "high," "medium," or "low" priority for further analysis. STP&E assigned 81 approaches as high priority, 56 as medium priority, and 55 as low priority.

Data Collection: Approach Research and Discussions

The RAND research team and STP&E collected data to describe each high-priority approach through desk research and semistructured discussion with SMEs. Based on access to SMEs, RAND and STP&E divided responsibility for data collection. RAND researchers collected data on 54 high-priority approaches down-selected by STP&E. This section describes RAND's data collection process.

Our first phase of data collection was desk research. We began by developing a set of questions to answer, describing each approach for subsequent analysis:

1. Under what circumstances (risks or opportunities) is this approach appropriate to take?
2. To which of the Strategy Objectives (see page Chapter Four) could the approach apply?
3. What ultimate outcome or effect is intended when this approach is implemented?
   a. Are there ways to measure or track how well this approach produces that effect?
   b. Are there downsides or other negative consequences expected to use this approach?
4. Under what circumstances is this approach most and least appropriate or responsive?
   a. What types of technologies? Why?
   b. Which lifecycle stages? Why?

    c.   Which market conditions? Why?

    d.   What types of entities are potential parties or beneficiaries?

    e.   Is this approach for defense, dual-use, or commercial technology? Where on the spectrum?

    f.   Is this approach intended to address the competitiveness of U.S. firms?

    g.   Is this approach intended to address military access to commercial goods?

    h.   Is this approach intended to address U.S.-held intellectual property and trade secrets?

5.   What are the qualifying (or "entry") requirements to use this approach?

    a.   What color of money is required (if applicable)?

    b.   Are there requirements about technology maturity or manufacturing readiness (TRL/MRL)?

    c.   Security requirements?

    d.   Workforce qualifications?

    e.   Are there restrictions around intellectual property?

6.   What is the timeframe of the process? What does it take to implement? How long after would the effect be realized?

    a.   How long is the pre-coordination timeframe (if applicable)?

    b.   How long after would one know if the approach succeeded or failed?

    c.   Is there a specific planning cycle or is the approach available throughout the fiscal year? When in the cycle is funding needed (if applicable)?

7.   From where does the funding for this approach come?

8.   Are there other approaches, policies, or processes that interact with this approach?

9.   Identify relevant publicly available reports, guidance, or frequently asked questions.

10. Are there any specific practices or implementation lessons that make this approach more effective in the promote/protect role?

11. For each practice identified above, identify a successful practice guidance document or point of contact.

12. Briefly describe an example of when this approach was used.

From May 2021 through September 2021, we compiled information about prioritized approaches using the questions as a guide. Data sources included government publications, peer-reviewed articles, think tank literature, and media presented by agency personnel (e.g., presentations, published interviews). Desk research also aided in preparing for our discussions with SMEs, by identifying points of contact and gaps in publicly available information.

Our second phase of data collection comprised semi-structured discussions with SMEs. We developed a protocol to guide discussions with SMEs, devoting special attention to gaps or uncertainties in the desk research findings. All discussions occurred between May 2021 and September 2021 and involved at least three RAND researchers with at least one SME. Table A.2 summarizes the discussions held.

TABLE A.2
Summary of Discussions with Approach Owners

Office	Department/Agency	Approach(es) Informed
Air Force Smart IP Cadre	Air Force	IP Acquisition, Licensing, and Management
Air Force Technology Transfer and Transition Program	Air Force	Air Force Technology Transfer
Defense Advanced Research Projects Agency	Defense	DARPA Investment
Defense Innovation Unit	Defense	DIU Investment; National Security Innovation Capital (NSIC) Investment
Employment and Training Administration	Labor	Apprenticeship Expansion Grants; Apprenticeship Expansion Contracts; Job Corps Training and Education; Registered Apprenticeship Program Occupational Training
Federal Bureau of Investigation	Justice	FBI Outreach
Intelligence Advanced Research Projects Activity	Office of the Director of National Intelligence	Intelligence Advanced Research Projects Activity (IARPA) Investment
Internal Revenue Service	Treasury	Research and Experimentation Tax Incentives
Loan Programs Office	Energy	Energy Infrastructure Loans and Loan Guarantees
National Spectrum Consortium	[Consortium]	Hosting 5G Demonstrations
Office of the Under Secretary of Defense for Acquisition and Sustainment, Office of Small Business Programs	Defense	Small Business Investment Company (SBIC) Program Investment
OUSD(I&S): Defense Counterintelligence and Security Agency	Defense	Critical Technology Protection; Information Classification Determinations
Office of the Under Secretary of Defense for Personnel/Defense Technology Security Administration: International Engagement Directorate	Defense	Technology Security and Foreign Disclosure (TS&FD) Processes
Office of the Under Secretary of Defense for Research and Engineering, Basic Research	Defense	J-1 Visa Waivers; Multidisciplinary University Research Initiative (MURI) Investment
Office of the Under Secretary of Defense for Research and Engineering, Prototypes and Experiments	Defense	Rapid Reaction Technology Office (RRTO) Investment
Office of the Under Secretary of Defense for Research and Engineering, Resilient Systems	Defense	Anti-Tamper Policy; Program Protection

Table A.2—continued

Office	Department/Agency	Approach(es) Informed
Office of the Under Secretary of Defense for Research and Engineering, Small Business and Technology Partnerships (SB&TP)	Defense	Rapid Innovation Fund Investment
U.S. Naval Research Laboratory	Navy	Navy Technology Transfer (Navy T2)
U.S. Patent and Trademark Office	Commerce	Patenting

Data Analysis: Approach Coding and Validation

Having collected data on the 54 high-priority approaches, we coded each approach to enable comparing approaches and validating them for inclusion in the P&P Tool, and to accommodate the P&P Tool's functionality. Comparing approach coding illuminated the following adjustments to the list of included approaches:

- 19 approaches that could be combined into four because they do not differ along coded attributes
- two approaches to be split, resulting in an additional two approaches
- three approaches to be removed as ambiguous
- three approaches to be removed as inactive.

These adjustments resulted in a **total of 35 approaches to include in the final P&P Tool**. Coding was also necessary for P&P Tool functionality by standardizing key approach characteristics into machine-recognizable binary values (zeros and ones).

A coding schema was developed including attributes related to technology strategy, technology, and acceptable conditions (see Chapter Three). We decomposed each of these three categories into sets of two types of questions about each attribute: one type of question to guide coding and one type to present to users in the P&P Tool. For example, for TRL, we ask

- [to coder]: Can this approach be used if the technology/service/process (currently or estimate at time of approach use) is at TRL [select all that apply, from TRL 1–9]?
- [to tool user]: What is the TRL of the technology/service/process (currently or estimate at the time of approach use) [select all that apply, from TRL 1–9]?

The schema was tested by each independently coding a subset of five diverse approaches and reviewing their results together. Reviewing the test codes led to refining attribute definitions and clarifying coding procedures. After having finalized attribute definitions and coding procedures (see Chapter Three), we proceeded to code the remaining approaches. Two researchers independently coded each approach, then discussed their results to present differences to a third researcher with subject matter expertise for validation and adjudication

of differences. We tested and refined the questions designed to guide tool users based on this experience and the refinements in definitions and queries.

Use Cases and Testing

We tested and refined the framework using case studies (see Appendix B), as well as scenarios and inputs of interest to different user groups. Cases were designed based on ample information available to RAND and a high degree of expected variation in tool output. Appendix B provides details about each case, but for the purposes of tool development, testing cases provided several key lessons:

- Approach coding updates were necessary to provide expected results in one scenario.
- Revisions to the user interface, including input choice wording and layout, clarified the link between user input and expected outputs.
- Broadening input selections, or displaying proximate approaches, can help identify novel approach applications or alternative strategies that the user may not have initially considered.

Definitions

The following definitions were used to ensure consistency in coding and communication within the project and tool development broadly.

Approach (tool): actions or processes that DoD may take or influence to realize the objectives expressed in the *National Strategy for Critical and Emerging Technologies within the National Security Innovation Base* (NSIB). Examples include an investment decision; a change or proposed change to legislation, regulation, policy, or procedure; or cooperation with other actors in the NSIB.

Government: U.S. federal, state, local, tribal, and territorial legislative, executive, and judicial organizations and persons whose powers are ultimately vested by the U.S. Constitution.

Industry: private sector organizations and persons in or otherwise related to the NSIB.

Investment: a direct allocation of funds for the purpose of achieving some material result in the future.

Non-Investment: an action or process that does not involve a direct funding allocation but is for the purpose of achieving some material result in the future.

Promote: to intervene in the NSIB to support critical and emerging technologies and their associated innovation base (from project description).

Protect: to intervene in the NSIB in "defense of U.S. critical technologies from adversaries against illegal export, theft, espionage, and reverse engineering" (GAO, 2021, p. 4).

Application of the Tool with Case Studies

We tested the framework using a series of case studies by inputting the case parameters into the P&P Tool. These case studies presented technologies of interest to DoD and protect and promote scenarios that have occurred and challenged DoD decisionmaking. These case studies were used as a test to examine how well the framework performs and to provide feedback for its refinement and improvement of the P&P Tool. Our methodology for developing these case studies is provided in Appendix A. This appendix provides a brief summary of each case, how it was applied to the framework, and its results.

National Security Space Launch

The National Security Space Launch (NSSL), formerly known as the Evolved Expendable Launch Vehicle (EELV), provides access to space for DoD and other national security missions. Launch systems consist of launch vehicles, infrastructure, and support systems. This case study examined heavy spacelift, which is rarely used by the commercial sector due to cost, leaving the government as the primary customer. RAND researchers completed an independent assessment of the global lift market in 2020 and found the commercial market for heavy lift is unable to provide the demand or diversification to drive costs lower or to increase competition (Triezenberg et al., 2020). In the United States, without a diversified commercial demand for heavy lift, few providers are available, those few providers cater almost exclusively to government customers, and the result is a lack of competition for injecting new innovation or for lowering costs. NSSL is the exclusively national security segment of heavy lift, but the service offerings are similar irrespective of customer segment.

Translation to Framework inputs

The market environment and recent RAND research in this field informed the set of framework inputs shown in Table B.1. First, we assessed NSSL as having TRL and MRL levels of 9 each, since NSSL is already operational and provided annually. While room for innovation exists in both technology and manufacturing improvements, such innovations do not preclude current launches from occurring. Second, we assessed that NSSL is dominated by the military market due to the extensive research conducted by a RAND study team in 2020 (Triezenberg et al., 2020).

TABLE B.1

Framework Inputs for National Security Space Launch

Framework Field	NSSL Inputs
Current TRL	9
Current MRL	9
Software	No
Application	Military
Dominate market	Military
NSIB improvements	Manufacturing; innovation
Partners	Traditional and non-traditional
Desired TRL	N/A
Desired MRL	10
Funding	Government
Timeframe	Flexible
Rank risks	—
Sample COAs	• Preserve/expand capability • Retain access to critical suppliers • Foster innovation • Tap commercial capability • Diversify and strengthen supplier base • Assure U.S. government access to strategic materials • Secure the supply chain

As a result of these assessments, we determined that no future TRL level could be identified and that a desired future MRL would indicate an improvement over the current state. Transitioning to MRL 10 could indicate cost improvements in mass production, and such cost improvements would be a substantive improvement to the government.

We selected COAs for this technology that indicate an increased need for innovation; an increase in the supplier base (in order to create price competition and innovation competition); and the need to secure national security launches from foreign interference.

Framework outputs

NSSL is an industry that has been heavily studied for its protect and promote challenges. The P&P Tool resulted in four outputs:

- Industry Intermediaries to Expand Registered Apprenticeship Programs
- Job Corps
- Registered Apprenticeship Program
- Small Business Investment Company (SBIC) Program.

The first three outputs—Industry Intermediaries to Expand Registered Apprenticeship Programs, Job Corps, and Registered Apprenticeship Program—all represent opportunities to grow talent in the NSSL workforce, and doing so may stimulate innovation. Meanwhile, SBIC offers an opportunity to encourage new market entrants, though small businesses will likely be challenged by the enormous costs associated with heavy launches.

Discussion

We assess that the narrow scope of these outputs indicates the narrow options the government currently has in this industry. As the RAND independent assessment from 2020 concluded, promoting this market is difficult without new entrants (new suppliers) who will grow the current supplier base and create competition for both cost and innovation. However, the small number of launches each year are insufficient to support a larger supplier base, and these challenges are reflected in the few and narrowly focused outputs from the framework.

Universal Quantum Computing

Universal quantum computing will rely on new forms of hardware and processors. For this case study, quantum computing is any form of computing that uses quantum bits (called qubits), which, because of the properties of quantum mechanics, can be in a superposition of values between 0 and 1, potentially providing an exponential increase in computational power. We focused on quantum computing hardware, including quantum processors and the input/output devices and associated equipment, such as cryogenics for superconducting qubits. Quantum computing advances may affect all fields of science, including biotech, materials sciences, and others, and it poses a threat to existing digital encryption. The single greatest challenge today is in reaching the next technical breakthrough.

Translation to Framework inputs

Our framework inputs for universal quantum computing are shown in Table B.2. When deciding on the inputs for our framework, establishing a current TRL and MRL was challenging. Some companies claim to have working quantum computers that customers can rent for their own calculations, and such claims would imply that quantum computing exists (TRL 9 or higher) and has been manufactured (MRL 9). We assessed that these systems can more aptly be described as prototypes, because companies have been unable and unwilling to sell quantum computers—indicating that the hardware is not mature enough to be shared with the customer and is not ready for mass production—and several key technological breakthroughs have not yet been achieved.

Based on the current market landscape, we further assessed the universal quantum computing is dominated by the commercial market, with the government merely a minor customer. We made this assessment based on several factors, and this assessment has implica-

TABLE B.2
Framework Inputs for Universal Quantum Computing

Framework Field	NSSL Inputs
Current TRL	3–5
Current MRL	NA
Software	Mixed
Application	Dual-use
Dominate market	Commercial
NSIB improvements	None
Partners	Any
Desired TRL	6–7
Desired MRL	NA
Funding	Cost-share
Timeframe	Flexible
Rank risks	—
Sample COAs	• Foster innovation • Tap commercial capability • Develop and sustain the industrial and innovation workforce • Reduce foreign ownership, control, or influence • Assure U.S. government access to strategic materials • Protect the NSIB from cyber threats

tions for options in both protect and promote. First, the majority of investment in quantum computing globally seems to originate from nongovernmental sources. The United States leads the world in quantum computing by a comfortable margin, boasting IBM, Google, Honeywell, PsiQuantum, and Rigetti (Vermeer and Peet, 2020). Quantum development is not restricted to the private sector but extends into universities and other research entities. Second, the majority of use cases or desired applications for quantum computing globally seems to be nonmilitary or nondefense applications. Third, while defense or military applications for quantum computing are desired, it is thus far unclear whether the underlying technology—the hardware and software—for these applications would need to be any different from the technology used for nondefense applications (Vermeer and Peet, 2020). If this is true, then no military technologies would be needed, and all military buyers would simply purchase commercial systems, similar to most military purchases of other (nonquantum) computer products. On the other hand, it is possible that the underlying hardware will be the same for both defense and civilian applications, but only the software would be different. These assumptions informed our inputs in Table B.2 for a commercially dominated market with dual-use applications and cost-sharing.

Framework Outputs

Many possible mechanisms could be applied to universal quantum computing. Based on the selected inputs—combined with the limited approaches in the initial version of the P&P Tool—four approaches were identified as relevant:

- Defense Innovation Unit (DIU) investment
- International collaborative programs
- National Security Innovation Capital (NSIC)
- Small Business Investment Company (SBIC) Program.

Discussion

All these are investment programs aimed at development of applications, either commercial or military in application. Identifying the appropriate current TRL was not straightforward, and choosing a too mature TRL omitted certain promotion mechanisms. The greatest challenge in quantum computing is not a lack of funding. Selecting the "wrong" funding input omitted international collaborations, which could be vital to achieving a technological breakthrough. Interestingly, the international collaborative programs aim at acceleration of technology development without mechanisms in place to ensure protection for U.S. or military applications.

Case Study Outcomes

Use of the P&P Tool with these cases provided some lessons for effective use of the framework for identification or relevant approaches. The way that inputs are selected should reflect the breadth of options that are acceptable. Certain mechanisms are only available for specific TRLs, and therefore the selection of TRL should be as broad as possible to encourage all possible solutions included in the output. DoD seeks international collaborations for purposes other than joint funding, such as access to expertise and scientific collaboration. A case study that did not consider new funding omitted international collaborations. Mature, operational capabilities can suffer lack of innovation for creating the next major breakthrough. When TRL and MRL are both mature, too many promote mechanisms were omitted from the results.

Other lessons from these cases pertain more to the range of strategies and approaches that may be considered for a technology of interest. Considering the range of approaches available in the P&P Tool may inform the need for new approaches that DoD can create or should consider. When existing approaches that are only applicable to a specific type of technologies or sector (e.g., energy loans) are revealed by the tool, new analogous approaches for the technologies under consideration might be developed. The government's existing approaches are not always sufficient for all situations. New approaches may be needed as complex situations reveal limited existing options for government action.

List of Identified Approaches

This appendix contains the full list of identified approaches for government influence of the protection and promotion of technology.

TABLE C.1

Identified Approaches

No.	Approach Name	Agency	References
2	Countervailing Measures	Commerce	World Trade Organization, "Trade Guide: WTO Subsidies Agreement," webpage, undated. As of September 21, 2022: https://www.trade.gov/trade-guide-wto-subsidies
3	Electromagnetic spectrum management	Commerce	U.S. Department of Commerce, National Telecommunications and Information Administration, "Spectrum Management," webpage, undated. As of September 21, 2021: https://www.ntia.doc.gov/category/spectrum-management
4	Export controls (Commerce Control List)	Commerce	U.S. Department of Commerce, Bureau of Industry and Security, "Commerce Control List," webpage, undated. As of September 21, 2022: https://www.bis.doc.gov/index.php/regulations/commerce-control-list-ccl
5	Information and communications technology (ICT) supply chain transaction review	Commerce	U.S. Department of Commerce, "ICT Supply Chain," webpage, undated. As of September 21, 2022: https://www.commerce.gov/issues/ict-supply-chain
6	Export prohibitions (Lists of Parties of Concern)	Commerce	U.S. Department of Commerce, Bureau of Industry and Security, "List of Parties of Concern," webpage, undated. As of September 21, 2022: https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern
7	Patenting	Commerce	U.S. Department of Commerce, "Intellectual Property," webpage, undated. As of September 21, 2022: https://www.commerce.gov/issues/intellectual-property
8	Risk Management Framework (RMF)	Commerce	Department of Defense Instruction 8510.01, *Risk Management Framework for DoD Systems*, July 19, 2022.

Table C.1—continued

No.	Approach Name	Agency	References
9	Standards development, promotion, or change (NIST)	Commerce	National Institute of Standards and Technology, "Key Federal Law and Policy Documents: NTTAA & OMB A-119," webpage, undated. As of September 21, 2022: https://www.nist.gov/standardsgov/what-we-do/federal-policy-standards/key-federal-directives
10	5G standards development	Defense	U.S. Department of Defense, *Department of Defense 5G Strategy Implementation Plan: Advancing 5G Technology & Applications Securing 5G Capabilities*, 2020.
11	Intellectual Property Acquisition, Licensing, and Management	Defense	Space and Missile Systems Center, Office of the Staff Judge Advocate, *Acquiring and Enforcing the Government's Rights in Technical Data and Computer Software Under Department of Defense Contracts: A Practical Handbook for Acquisition Professionals*, Ninth Edition, October 2018. As of September 23, 2022: https://www.dau.edu/pdfviewer/Source/Guidebooks/Technical-Data-and-Computer-Software-Rights-Handbook.pdf
12	IR&D Technology Interchange Meetings	Defense	Defense Innovation Marketplace, "Technology Interchange Meetings," webpage, undated. As of September 23, 2022: https://defenseinnovationmarketplace.dtic.mil/technology-interchange-meetings/
13	AFWERX AFVentures	Defense	AFWERX, "AFVentures," webpage, undated. As of November 28, 2022: https://afwerx.com/afventures-overview/
14	AFWERX Prime	Defense	AFWERX, "Prime," webpage, undated. As of September 23, 2022: https://afwerx.com/prime-overview/
15	Industry & Academic Outreach and Coordination	Defense	[Varies with program]
17	Air Force Pitch Days	Defense	AFWERX, "Air Force Pitch Day," webpage, undated.. As of September 23, 2022: https://www.afsbirsttr.af.mil/Events/Pitch-Days/
18	Air Force Seedlings for Disruptive Capabilities	Defense	Air Force Research Laboratory, "Seedlings for Disruptive Capabilities," webpage, undated. As of September 23, 2022: https://afresearchlab.com/technology/successstories/seedlings-for-disruptive-capabilities/
20	Air Force Technology Transfer	Defense	Air Force Technology Transfer and Transition, "Overview," webpage, undated. As of September 23, 2022: https://www.aft3.af.mil/DAF-T3-Program/Overview/
21	Air Force WarTech	Defense	Air Force Research Laboratory, "WarTech," webpage, undated. As of November 28, 2022: https://afresearchlab.com/technology/wartech/

Table C.1—continued

No.	Approach Name	Agency	References
22	Anti-Tamper and Technology Authentication	Defense	U.S. Department of Defense, Anti-Tamper Executive Agent, "DoD Anti-Tamper Website," website, undated. As of September 23, 2022: https://at.dod.mil/
			U.S. Government Accountability Office, *DoD Critical Technologies: Plans for Communicating, Assessing, and Overseeing Protection Efforts Should Be* Completed, Washington, D.C., GAO-21-58, January 202.
23	Army Industrial Security Specialists	Defense	Headquarters, Department of the Army, G-2, Industrial Security, "Industrial Security," webpage, undated. As of September 23, 2022: https://www.dami.army.pentagon.mil/site/industsec/aboutus.aspx
24	Army Venture Capital Initiative	Defense	John A. Parmentola and Robert S. Rohde, "Army Venture Capital Initiative," *Army AL&T*, November–December 2003. As of November 28, 2022: https://asc.army.mil/docs/pubs/alt/2003/6_NovDec/articles/28_Army_Venture_Capital_Initiative_200306.pdf
25	Assessing Defense Industrial Capabilities	Defense	AcqNotes, "Defense Industrial Capabilities Assessment," webpage, updated July 22, 2021. As of September 23, 2022: https://acqnotes.com/acqnote/careerfields/defense-industrial-capabilities-assessment
26	Business Intelligence and Analytics (BI&A)	Defense	Assistant Secretary of Defense for Industrial Base Policy, "Industrial Base Policy:
			Industry and International Engagement," webpage, undated. As of November 28, 2022: https://www.businessdefense.gov/iie/index.html
27	Changing acquisition business practices	Defense	Defense Technical Information Center, "Section 809 Panel," webpage, undated. As of September 23, 2022: https://discover.dtic.mil/section-809-panel/
28	Collaborative Technology and Research Alliances	Defense	Army Research Laboratory, "Collaborative Alliances," webpage, undated. As of September 22, 2022: https://www.arl.army.mil/business/collaborative-alliances/
29	Cornerstone Other Transaction Agreement or development and sustainment of R&D activities and prototyping through Consortia	Defense	U.S. Army, "Cornerstone," webpage, undated. As of September 23, 2022: https://cornerstone.army.mil/
30	Program Protection	Defense	Department of Defense Instruction 5200.39, *Critical Program Information (CPI) Identification and Protection Within Research, Development, Test, and Evaluation (RDT&E)*, May 28, 2015, incorporating Change 3, effective October 1, 2020.

Table C.1—continued

No.	Approach Name	Agency	References
31	Critical Technology Protection	Defense	Defense Counterintelligence and Security Agency, "Industrial Security Directorate (ISD)," webpage, undated. As pf September 23, 2022: https://www.dcsa.mil/mc/ctp/
32	CyberWorx	Defense	Congressional Research Service, *The Global Context for Research and Development and Implications for the DOD*, Washington, D.C., R45403, 2018.
33	Defense Advanced Research Projects Agency (DARPA) Investment	Defense	Defense Advanced Research Projects Agency, "Opportunities," webpage, undated. As of September 23, 2022: https://www.darpa.mil/work-with-us/opportunities
34	Defense Industrial Base Assessments	Defense	Department of Defense Instruction 5000.60, *Defense Industrial Base Assessments*, July 18, 2014, incorporating Change 3, effective August 5, 2022.
36	Defense Innovation Unit (DIU) Investment	Defense	Defense Innovation Unit, website, undated. As of September 23, 2022: https://www.diu.mil
37	Defense Priorities and Allocations System Program (DPAS)	Defense	Executive Order 13603, *National Resources Preparedness*, March 16, 2012. As of September 23, 2022: https://obamawhitehouse.archives.gov/the-press-office/2012/03/16/executive-order-national-defense-resources-preparedness
			Defense Contract Management Agency, "Defense Priorities & Allocations System (DPAS)," webpage, undated. As of September 23, 2022: https://www.dcma.mil/DPAS/
			U.S. Department of Commerce, Bureau of Industry and Security," "Defense Priorities and Allocations System (DPAS)," webpage, undated. As of September 23, 2022: https://www.bis.doc.gov/index.php/other-areas/strategic-industries-and-economic-security-sies/defense-priorities-a-allocations-system-program-dpas
38	Defense University Research Instrumentation Program (DURIP)	Defense	U.S. Department of Defense, "DOD Awards $50 Million in University Research Equipment Awards," December 1, 2020. As of September 23, 2022: https://www.defense.gov/Newsroom/Releases/Release/Article/2430566/dod-awards-50-million-in-university-research-equipment-awards/
39	Demand Planning/ Demand Forecasting	Defense	Department of Defense Manual 4140.01, Volume 2, *DoD Supply Chain Materiel Management Procedures: Demand and Supply Planning*, November 9, 2018.
40	Digital Acquisition	Defense	Will Roper, *There Is No Spoon: Thew New Digital Acquisition Reality*, Washington, D.C.: U.S. Department of Defense, October 7, 2020. As of September 23, 2022: https://software.af.mil/wp-content/uploads/2020/10/There-Is-No-Spoon-Digital-Acquisition-7-Oct-2020-digital-version.pdf

Table C.1—continued

No.	Approach Name	Agency	References
41	Digital Engineering	Defense	U.S. Department of Defense, *Digital Engineering Strategy*, June 2018. As of September 23, 2022: https://ac.cto.mil/wp-content/uploads/2019/06/2018-Digital-Engineering-Strategy_Approved_PrintVersion.pdf
42	DoD Cybersecurity Maturity Model Certification (CMMC) Program	Defense	U.S. Department of Defense, Chief Information Officer, "Cybersecurity Maturity Model Certification," webpage, undated. As of November 28, 2022: https://dodcio.defense.gov/CMMC/
43	DoD Foreign Investment Review	Defense	Assistant Secretary of Defense for Industrial Base Policy, "Industrial Base Policy: Global Investment and Economic Security (GIES)," webpage, undated. As of November 28, 2022: https://www.businessdefense.gov/iie/index.html https://www.businessdefense.gov/fir/index.html
44	5G workforce development collaboration	Defense	U.S. Department of Defense, *Department of Defense 5G Strategy Implementation Plan: Advancing 5G Technology & Applications Securing 5G Capabilities*, 2020.
45	DoD Manufacturing Technology (ManTech) Program; Services (Army, Navy, Air Force), Defense Logistics Agency, Missile Defense Agency ManTech Programs	Defense	U.S. Department of Defense, Manufacturing Technology Program, homepage, undated. As of November 28, 2022: https://www.dodmantech.mil/
49	DoD Trusted Capital Marketplace	Defense	U.S. Department of Defense, "Trusted Capital," webpage, undated. As of September 23, 2022: https://www.acq.osd.mil/tc/index.html Public Law 115-91, National Defense Authorization Act for Fiscal Year 2018, Section 1711, December 12, 2017. Public Law 116-283, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Section 213(c), January 1, 2021.
50	DoD-funded Manufacturing Innovation Institute (MII)	Defense	U.S. Department of Defense, Manufacturing Technology Program, "About the Department of Defense Manufacturing Innovation Institutes," webpage, undated. As of November 28, 2022: https://www.dodmantech.mil/Manufacturing-Innovation-Institutes/
51	Domestic Content Restrictions	Defense	Congressional Research Service, *Defense Primer: U.S. Defense Industrial Base*, Washington, D.C., IF10548, January 22, 2021.
52	Educational Partnership Agreements	Defense	Army Research Laboratory, "Partnership Methods and Opportunities," webpage, undated. As of September 22, 2022: https://www.arl.army.mil/business/partnership/

Table C.1—continued

No.	Approach Name	Agency	References
53	Expansion of Productive Capacity and Supply	Defense	Congressional Research Service, *The Defense Production Act of 1950: History,* *Authorities, and Considerations for Congress*, Washington, D.C., R43767, March 2, 2020.
54	Facility Clearance (FCL)	Defense	Defense Security Service, *Facility Clearance Process*, undated. As of September 23, 2022: https://www.airforcesmallbiz.af.mil/Portals/58/documents/ SB_Guide_Facility_Clearance_Process_FINAL_LINKS. PDF?ver=2018-07-03-095656-667
56	Fragility and Criticality Assessments	Defense	Assistant Secretary of Defense for Industrial Base Policy, "Industrial Base Policy: Policy, Analysis, and Transition (PA&T)," webpage, undated. As of November 28, 2022: https://www.businessdefense.gov/ai/index.html
57	General Provisions	Defense	Congressional Research Service, *The Defense Production Act of 1950: History,* *Authorities, and Considerations for Congress*, Washington, D.C., R43767, March 2, 2020.
58	Hosting 5G Demonstrations	Defense	U.S. Department of Defense, *Department of Defense 5G Strategy Implementation Plan: Advancing 5G Technology & Applications Securing 5G Capabilities*, 2020.
59	Industrial Assessments	Defense	Assistant Secretary of Defense for Industrial Base Policy, "Resources," webpage, undated. As of November 28, 2022: https://www.businessdefense.gov/resources.html
60	Industrial Base Analysis and Sustainment (IBAS)	Defense	Assistant Secretary of Defense for Industrial Base Policy, "Industrial Base Policy: Industrial Base Analysis and Sustainment (IBAS)," webpage, undated. As of November 28, 2022: https://www.businessdefense.gov/ai/ibas/index.html
61	Industry Outreach	Defense	Assistant Secretary of Defense for Industrial Base Policy, "Industry Engagement Pre-Meeting Questions," webpage, undated. As of November 28, 2022: https://www.businessdefense.gov/iie/contact-engagement. html
62	International Science and Technology Engagement	State	U.S. Department of Defense, *Department of Defense International Science and Technology Engagement Strategy: A Unified Approach to Strengthen Alliances and Attract New Partners*, December 11, 2020.
65	J-1 Visa Waivers	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
66	Joint Acquisition Protection and Exploitation Cell	Defense	Department of Defense Research and Engineering Enterprise, Science and Technology Program Protection, "Maintaining Technology Advantage (MTA)," webpage, undated. As of November 28, 2022: https://rt.cto.mil/stpp/mta/

Table C.1—continued

No.	Approach Name	Agency	References
67	Market Research and Market Surveillance	Defense	U.S. Department of Defense, Defense Standardization Program Office, *Market Research: Gathering Information About Commercial Products and Services*, SD-5, December 2018. As of September 23, 2022: https://www.dau.edu/Lists/Events/Attachments/142/Guidance-SD-5_121818.pdf
68	Mentor-Protégé Program (MPP)	Defense	U.S. Department of Defense, Office of Small Business Programs, "Mentor-Protégé Program (MPP)," webpage, undated. As of September 23, 2022: https://business.defense.gov/Programs/Mentor-Protege-Program/
69	Mergers & Acquisitions (DoD IndPol)	Defense	Assistant Secretary of Defense for Industrial Base Policy, "Foreign Investment Review: Mergers & Acquisitions," webpage, undated. As of November 28, 2022: https://www.businessdefense.gov/fir/ma.html
71	Modular Open Systems Architecture	Defense	U.S. Department of Defense, "Defense Standardization Program," webpage, undated. As of September 23, 2022: https://www.dsp.dla.mil/Programs/MOSA/
72	Multidisciplinary University Research Initiative (MURI) Investment	Defense	Army Research Laboratory, "Multidisciplinary University Research Initiative (MURI)," webpage, undated. As of September 23, 2022: https://www.arl.army.mil/business/muri/ Office of Naval Research, "Multidisciplinary University Research Initiatives (MURI) Program," webpage, undated. As of September 23, 2022: https://www.nre.navy.mil/education-outreach/sponsored-research/university-research-initiatives/muri Air Force Office of Scientific Research, "AFOSR—Funding Opportunities—University Research Initiative (URI)," webpage, undated. As of September 23, 2022: https://www.afrl.af.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/2282120/afosr-funding-opportunities-university-research-initiative-uri/
73	Information Classification Determinations	Defense	Defense Counterintelligence and Security Agency, "National Industrial Security Program (NISP)," webpage, undated. As of September 23, 2022: https://www.dcsa.mil/mc/ctp/nisp/
74	National Security Innovation Capital (NSIC) Investment	Defense	National Security Innovation Capital, website, undated. As of September23, 2022: https://www.nsic.mil
76	Navy Technology Transfer (Navy T2)	Defense	U.S. Naval Research Laboratory, "Technology Transfer," webpage, undated. As of September 23, 2022: https://www.nrl.navy.mil/Doing-Business/Technology-Transfer/
77	Open Campus Initiative	Defense	Congressional Research Services, *The Global Context for Research and Development and Implications for the DOD*, Washington, D.C., R45403, June 2021.

Table C.1—continued

No.	Approach Name	Agency	References
78	Partnerships and cooperation agreements, memoranda of agreement, project agreements, and other international collaboration mechanisms	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
80	Rapid Innovation Fund Investment	Defense	Department of Defense Research and Engineering Enterprise, "Small Business and Technology Partnerships (SB&TP)," webpage, undated. As of September 23, 2022: https://rt.cto.mil/rtl-small-business-resources/
81	Rapid Reaction Technology Office (RRTO) Investment	Defense	Jon Lazar, "Rapid Reaction Technology Office (RRTO) Overview," briefing slides, undated. As of September 23, 2022: https://ndiastorage.blob.core.usgovcloudapi.net/ndia/2019/solic/Lazar.pdf
82	Research and Engineering Executive Committee	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
83	Resource Allocation (PPBE)	Defense	Department of Defense Directive 7045.14, *The Planning, Programming, Budgeting, and Execution (PPBE) Process*, January 25, 2013, incorporating Change 1, effective August 29, 2017.
84	Risk-based Security Operations (RISO)	Defense	Defense Counterintelligence and Security Agency, "Industrial Security Directorate (ISD)," webpage, undated. As of November 28, 2022: https://www.dcsa.mil/mc/isd/Risk-Based-Security-Oversight-RISO/
85	Scientific Services Program	Defense	Army Research Laboratory," Scientific Services Program," webpage, undated. As of September 23, 2022: https://www.arl.army.mil/business/scientific-services-program/
86	Small Business Innovative Research (SBIR) Program	Defense	Small Business Innovation Research, website, undated. As of September 23, 2022: https://www.sbir.gov/
			Matt Clancy, "An Example of High Returns to Publicly Funded R&D," *What's New Under the* Sun (Substack), May 21, 2021. As of September 23, 3022: https://mattsclancy.substack.com/p/an-example-of-high-returns-to-publicly
87	Small Business Technology Transfer (STTR) Program	Defense	Small Business Innovation Research, website, undated. As of September 23, 2022: https://www.sbir.gov/

Table C.1—continued

No.	Approach Name	Agency	References
88	Software Assurance & Hardware Assurance (JFAC)	Defense	Department of Defense Research and Engineering Enterprise, Strategic Technology Protection and Exploitation, "Joint Federated Assurance Center (JFAC)," webpage, undated. As of November 28, 2022: https://rt.cto.mil/stpp/syssec/jfac/
			Joint Federated Assurance Center, informational brochure, undated. As of September 23, 2022: https://rt.cto.mil/wp-content/uploads/2019/06/JFAC-Trifold-v5.pdf?csrt=10259386258236383335
89	SOFWERX	Defense	Congressional Research Service, *The Global Context for Research and Development and Implications for the DOD*, Washington, D.C., R45403, 2018.
90	TechLink	Defense	TechLink, "How to Work with Us," webpage, undated. As of September 23, 2022: https://techlinkcenter.org/resources/how-it-works
91	Technology Release and Foreign Disclosure (TS&FD) Processes	Defense	OSD, Defense Technology Security Administration, "Technology Release Policies," webpage, undated. As of September 23, 3022: https://www.dtsa.mil/SitePages/shaping-policy/technology-release-policies.aspx
92	The Militarily Critical Technology List	Defense	Department of Defense Instruction 3020.46, *The Militarily Critical Technologies List (MCTL)*, October 24, 2008, incorporating Change 2, effective October 15, 2018.
94	Vannevar Bush Faculty Fellowship	Defense	Office of the Under Secretary of Defense for Research and Engineering, Basic Research Office, "Vannevar Bush Faculty Fellowship," webpage, undated. As of September 23, 2022: https://basicresearch.defense.gov/Programs/Vannevar-Bush-Faculty-Fellowship/
95	Warstopper Program	Defense	Luis Villareal, "Industrial Capabilities and Warstopper Program," Defense Logistics Agency, briefing slides, dated June 27–30, 2011. As of September 23, 2022: https://ndiastorage.blob.core.usgovcloudapi.net/ndia/2011/DLA/ThursdayDLAIndustrialCapabilities.pdf
96	Wright Brothers Institute (WBI) partnerships	Defense	Congressional Research Service, *The Global Context for Research and Development and Implications for the DOD*, Washington, D.C., R45403, 2018.
97	International Cooperative Research & Development	Defense	U.S. Code, Title 10—Armed Forces, Section 2350a—Cooperative Research and Development Agreements: NATO Organizations; Allied and Friendly Foreign Countries.
99	Cybersecurity risk management services	DHS	Cybersecurity and Infrastructure Security Agency, *Services Catalog*, Autumn 2020. As of September 23, 2022: https://www.cisa.gov/sites/default/files/publications/FINAL_CISA%20Services%20Catalog%20v1.1_20201029_508_0.pdf

Table C.1—continued

No.	Approach Name	Agency	References
100	Counter-Proliferation Investigations	DHS	U.S. Department of Homeland Security, U.S. Immigration and Customs Enforcement, "Counter-Proliferation Programs," webpage, updated July 2021. As of September 23, 2020: https://www.ice.gov/factsheets/cpi
101	Critical Infrastructure and Resiliency	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Community and Infrastructure Resilience," webpage, updated September 2022. As of September 23, 2022: https://www.dhs.gov/science-and-technology/critical-infrastructure-and-resiliency
102	Customs Trade Partnership Against Terrorism (CTPAT)	DHS	U.S. Department of Homeland Security, U.S. Immigration and Customs Enforcement, "Arms and Strategic Technology Proliferation," webpage, updated January 2021. As of September 23, 2022: https://www.ice.gov/investigations/astp
			U.S. Department of Homeland Security, U.S. Customs and Border Protection, "CTPAT: Customs Trade Partnership Against Terrorism," webpage, updated August 2022. As of September 23, 2022: https://www.cbp.gov/border-security/ports-entry/cargo-security/ctpat
			U.S. Department of Homeland Security, U.S. Customs and Border Protection, "Customs-Trade Partnership Against Terrorism (C-TPAT): Exporter Eligibility Requirements," undated. As of September 23, 2022: https://www.cbp.gov/sites/default/files/documents/Exporter%20Eligiblity%20and%20Minimum%20Security%20Criteria.pdf
103	DHS Small Business Innovation Research (SBIR) Program	DHS	U.S. Department of Homeland Security, "Small Business Innovation Research Program," webpage, undated. As of November 28, 2022: https://www.dhs.gov/science-and-technology/sbir
104	Employment-based visas (various)	DHS	U.S. Department of Homeland Security, U.S. Immigration and Customs Enforcement, "Working in the United States," webpage, undated. As of September 23, 2022: https://www.uscis.gov/working-in-the-united-states
105	Harmonized Tariff Schedule	DHS	Office of the United States Trade Representative, "Tariff Schedules," webpage, undated. As of September 23, 2022: https://ustr.gov/issue-areas/industry-manufacturing/industrial-tariffs/tariff-schedules
106	Prize Challenges	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "DHS Prize Challenges," webpage, updated July 2022, As of September 23, 2022: https://www.dhs.gov/science-and-technology/prize-competitions
107	S&T Industry Partnerships (7 current programs, most relevant)	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Industry Partnerships," webpage, updated April 2022. As of September 23, 2022: https://www.dhs.gov/science-and-technology/office-public-private-partnerships#

Table C.1—continued

No.	Approach Name	Agency	References
108	Science and Technology Directorate (S&T) Interagency Office (IAO): Tech Scouting, Tech Forecasting, DoE Portfolio, Special Projects Portfolio, S&T Advisory Committee	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "International Partnerships," webpage, updated May 10, 2022. As of November 28, 2022: https://www.dhs.gov/science-and-technology/st-icpo
109	Science and Technology Directorate (S&T) International Cooperative Programs Office (ICPO)	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "International Partnerships," webpage, updated May 2022. As of September 23, 2022:https://www.dhs.gov/science-and-technology/st-icpo
110	Silicon Valley Innovation Program	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Silicon Valley Innovation Program," webpage, updated September 2022. As of September 23, 2022: https://www.dhs.gov/science-and-technology/svip
111	Technology Transfer & Commercialization	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Technology Transfer & Commercialization," webpage, updated July 2022. As of September 23, 2022: https://www.dhs.gov/science-and-technology/technology-transfer-program
112	U.S.-Israel Binational Industrial Research and Development Homeland Security program	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Binational Industrial Research and Development (BIRD) Program," webpage, updated September 2022. As of September 23, 2022: https://www.dhs.gov/science-and-technology/bird-hls
113	Access to supercomputing and other national science facilities (supercolliders)	Energy	U.S. Department of Energy, "Science & Innovation," webpage, undated. As of September 23, 2022: https://www.energy.gov/science-innovation
114	ARPA-E investment	Energy	Advanced Research Projects Agency–Energy, website, undated. As of September 23, 2022: https://arpa-e.energy.gov/
115	Critical technology partnerships and cooperative R&D centers (established via CRADA)	Energy	U.S. Department of Energy, Office of the General Counsel, "DOE Cooperative Research and Development Agreements," Order 483.1, July 28, 2011. As of September 23, 2022: https://www.energy.gov/gc/downloads/doe-cooperative-research-and-development-agreements

Table C.1—continued

No.	Approach Name	Agency	References
116	DOE Facilities and Infrastructure Restoration and Modernization Program	Energy	U.S. Department of Energy, Office of Management, Sustainability Performance Division, "DOE Facilities and Infrastructure Restoration and Modernization Program," webpage, undated. As of September 23, 2022: https://www.energy.gov/management/spd/doe-facilities-an d-infrastructure-restoration-and-modernization-program
118	Energy Infrastructure Loans and Loan Guarantees	Energy	U.S. Department of Energy, Loan Programs Office, homepage, undated. As of September 23, 2022: https://www.energy.gov/lpo/loan-programs-office
119	In-Q-Tel (IQT); B.Next; Emerge; Labs	IC	In-Q-Tel, "How We Work," webpage, undated. As of September 23, 2022: https://www.iqt.org/how-we-work/
120	Intelligence Advanced Research Projects Activity (IARPA) Investment	IC	Intelligence Advanced Research Projects Activity, homepage, undated. As of November 28, 2022: https://www.iarpa.gov/
124	International Cooperation and Agreements	International	Office of the United States Trade Representative, "Trade Agreements," webpage, undated. As of September 23, 2022: https://ustr.gov/trade-agreements
125	Trade related aspects of IP rights	Commerce	U.S. Patent and Trademark Office, "Trade Related Aspects of IP Rights," webpage, undated. As of September 23, 2022: https://www.uspto.gov/ip-policy/patent-policy/ trade-related-aspects-ip-rights
126	Wassenaar Arrangement Control Lists	State	The Wassenaar Arrangement, "Control Lists," webpage, updated September 2022. As of September 23, 3033: https://www.wassenaar.org/control-lists/
128	Antitrust law	Justice	*U.S. Department of Justice vs. United Technologies Corporation and Raytheon Company*, complaint, submitted May 26, 2020. As of September 23, 2022: https://www.justice.gov/opa/press-release/file/1262856/ download
129	Counterintelligence Authorizations	Justice	U.S. Department of Justice, "Sections and Offices: Counterintelligence and Export Control Section," webpage, undated. As of September 23, 2022: https://www.justice.gov/nsd/sections-offices#intelexport
130	FBI Outreach	Justice	Federal Bureau of Investigations, CI Domain Program, "Partnering to Protect Tomorrow's Technology Today," brochure, undated. As of September 23, 2022: https://ucr.fbi.gov/investigate/counterintelligence/ partnering-to-protect-tomorrows-technology-today-brochure
131	Diversion Control Division	Justice	Drug Enforcement Administration, Diversion Control Division, "Program Description," webpage, undated. As of September 23, 2022: https://www.deadiversion.usdoj.gov/prog_dscrpt/index.html
132	Grants	Justice	U.S. Department of Justice, "Grants," webpage, undated. As of September 23, 2022: https://www.justice.gov/grants

Table C.1—continued

No.	Approach Name	Agency	References
133	Law Enforcement	Justice	U.S. Department of Justice, "About DOJ," webpage, undated. As of September 23, 2022: https://www.justice.gov/about
134	Litigation	Justice	U.S. Department of Justice, "About DOJ," webpage, undated. As of September 23, 2022: https://www.justice.gov/about
135	Technology Innovation for Public Safety (TIPS) Program	Justice	U.S. Department of Justice, Office of Justice Programs," Opportunities & Awards," webpage, undated. As of September 23, 2022: https://www.ojp.gov/funding/explore/current-funding-opportunities
137	Apprenticeship.gov	Labor	Apprenticeship.gov, website, undated. As of September 23, 2022: https://www.apprenticeship.gov/
138	Apprenticeship Expansion Grants	Labor	Sarna, Maureen, Julie Strawn, and Abt Associates, "Career Pathways Implementation Synthesis: Appendix 3A: Career Pathways Implementation Matrix," Excel file, 2018. As of September 23, 2022: https://www.dol.gov/sites/dolgov/files/OASP/legacy/files/3a-Matrix-Career-Pathways-Implementation-Synthesis.xlsx
139	CareerOneStop Business Center AKA "American Job Center"	Labor	CareerOneStop Business Center, website, undated. As of September 23, 2022: https://www.careeronestop.org/BusinessCenter/default.aspx
140	H-1B One Workforce Grant Program	Labor	Apprenticeship.gov, "Active Grants and Contracts," webpage, undated. As of September 23, 2022: https://www.apprenticeship.gov/investments-tax-credits-and-tuition-support/active-grants-and-contracts
			U.S. Department of Labor, Employment and Training Administration, "H-1B Skills Training Grants," webpage, undated. As of November 28, 2022: https://www.dol.gov/agencies/eta/skills-grants/h1-b-skills-training
141	Indian and Native American Programs	Labor	U.S. Department of Labor, Employment and Training Administration, "Indian and Native American Programs," webpage, undated. As of September 23, 2022: https://www.dol.gov/agencies/eta/dinap
142	Apprenticeship Expansion Contracts	Labor	https://www.apprenticeship.gov/investments-tax-credits-and-tuition-support/active-grants-and-contracts
144	Job Corps Training and Education	Labor	Job Corps, information brochure, undated. As of September 23, 2022: http://s3-us-west-2.amazonaws.com/jobcorps.gov/2017-04/Job_Corps-employers_brochure.pdf
146	Pension Benefit Guaranty Corporation (PBGC) protections	Labor	Pension benefit Guaranty Corporation, "About PBGC," webpage, undated. As of September 23, 2022: https://www.pbgc.gov/about/how-pbgc-operates

Table C.1—continued

No.	Approach Name	Agency	References
147	Registered Apprenticeship Program Occupational Training	Labor	Apprenticehip.gov, "Registered Apprenticeship Program," webpage, undated. As of September 23, 2022: https://www.apprenticeship.gov/employers/registered-apprenticeship-program
148	Transition Assistance Program, Veterans' Employment and Training Service Apprenticeship Pilot	Labor	U.S. department of Labor, Veterans' Employment and Training Service, "Transition Assistance Program," webpage, undated. As of September 23, 2022: https://www.dol.gov/agencies/vets/programs/tap
149	Presidential actions (Executive Orders, Memoranda, Proclamations)	Others	Vivian S. Chu and Todd Garvey, *Executive Orders: Issuance, Modification,* *And Revocation*, Washington, D.C.: Congressional Research Service, RS20846, April 16, 2014.
150	Free Trade Agreements	Others	Office of the U.S. Trade Representative, "Free Trade Agreements," webpage, undated. As of September 23, 2022: https://ustr.gov/issue-areas/industry-manufacturing/industrial-tariffs/free-trade-agreements
151	Indian Incentive Program (IIP)	Others	U.S. Department of Defense, Office of Small Business Programs, "Indian Incentive Program (IIP), webpage, undated. As of September 23, 2022: https://business.defense.gov/Programs/Indian-Incentive-Program/
152	Miscellaneous Tariff Bills	Others	Office of the U.S. Trade Representative, "Miscellaneous Tariff Bills," webpage, undated. As of September 23, 2022: https://ustr.gov/issue-areas/industry-manufacturing/industrial-tariffs/miscellaneous-tariff-bills
153	National Defense Authorization Act prohibitions	Others	U.S. Department of Defense, "DOD Releases List of Additional Companies, In Accordance with Section 1237 of FY99 NDAA," press release, January 14, 2021: https://www.defense.gov/News/Releases/Release/Article/2472464/dod-releases-list-of-additional-companies-in-accordance-with-section-1237-of-fy/
154	Other Tariff Initiatives	Others	Office of the U.S. Trade Representative, "Other Tariff Initiatives," webpage, undated. As of September 23, 2022: https://ustr.gov/issue-areas/industry-manufacturing/industrial-tariffs/other-tariff-initiatives
155	Rulemaking Process (e.g., FAR)	Others	Office of the Federal register, "A Guide to the Rulemaking Process," undated. As of September 23, 2022: https://www.federalregister.gov/uploads/2011/01/the_rulemaking_process.pdf
156	Rules of Origin	Others	Office of the U.S. Trade Representative, "Rules of Origin," webpage, undated. As of September 23, 2022: https://ustr.gov/issue-areas/industry-manufacturing/industrial-tariffs/rules-origin

Table C.1—continued

No.	Approach Name	Agency	References
157	7(j) Management and Technical Assistance Program	SBA	U.S. Small Business Administration, "7(j) Management and Technical Assistance Program," webpage, undated. As of September 23, 2022: https://www.sba.gov/federal-contracting/contractin g-assistance-programs/7j-management-technical-assista nce-program
158	8(a) Business Development program	SBA	U.S. Small Business Administration, "7(j) Management and Technical Assistance Program," webpage, undated. As of September 23, 2022: https://www.sba.gov/federal-contracting/contractin g-assistance-programs/8a-business-development-program
159	Employee Trusts Program	SBA	U.S. Small Business Administration, "8(a) Business Development Program," webpage, undated. As of September 23, 2022: https://www.sba.gov/brand/assets/sba/sba-lenders/ESOP_ Borrower_Fact_Sheet.pdf
160	Historically Underutilized Business Zone (HUBZone)	SBA	U.S. Small Business Administration, "HUBZone Program," webpage, undated. As of September 23, 2022: https://www.sba.gov/federal-contracting/ contracting-assistance-programs/hubzone-program
161	Small Business Investment Company (SBIC) Program Investment	SBA	U.S. Small Business Administration, "Investment Capital," webpage, undated. As of September 23, 2022: https://www.sba.gov/funding-programs/investment-capital
162	Service-Disabled Veteran-Owned Small Businesses program	SBA	U.S. Small Business Administration, "Veteran Assistance Programs," webpage, undated. As of September 23, 2022: https://www.sba.gov/federal-contracting/ contracting-assistance-programs/service-disabled-vetera n-owned-small-businesses-program
163	Women-Owned Small Business Federal Contracting Program	SBA	U.S. Small Business Administration, "Women-Owned Small Business Federal Contracting Program," webpage, undated. As of September 23, 2022: https://www.sba.gov/federal-contracting/ contracting-assistance-programs/women-owned-smal l-business-federal-contracting-program
165	Consent Agreements	State	Torres Trade Law, "Lessons from the L3Harris Technologies Consent Agreement with DDTC," October 11, 2019. As of September 23, 2022: https://www.torrestradelaw.com/posts/Lesson s-from-the-L3Harris-Technologies-Consent-A greement-with-DDTC/182
166	Arms Exports (Conventional Arms Transfer)	State	The White House, "National Security Presidential Memorandum Regarding U.S. Conventional Arms Transfer Policy," NSPM-10, April 19, 2018. As of September 23, 2022: https://fas.org/irp/offdocs/nspm/nspm-10.pdf
168	Direct Commercial Sales (DCS)	State	U.S. Department of State, Bureau of Political-Military Affairs, "U.S. Arms Sales and Defense Trade," webpage, January 20, 2021. As of September 23, 2022: https://www.state.gov/u-s-arms-sales-and-defense-trade/

Table C.1—continued

No.	Approach Name	Agency	References
169	Direct Line for American Business	State	U.S. Department of State, "Direct Line for American Business," webpage, undated. As of September 26, 2022: https://www.state.gov/direct-line-for-american-business/
170	Economic Sanctions Policy and Implementation (SPI)	State	U.S. Department of State, Division for Counter Threat Finance and Sanctions, "Economic Sanctions Policy and Implementation," webpage, undated. As of September 26, 2022: https://www.state.gov/economic-sanctions-policy-an d-implementation/
171	Embassy Science Fellows Program	State	U.S. Department of State, Office of Science and Technology Cooperation," Embassy Science Fellows Program," webpage, undated. As of September 26, 2022: https://www.state.gov/programs-office-of-science-an d-technology-cooperation/embassy-science-fellow s-program/
173	Foreign Military Sales (FMS)	State	U.S. Department of State, Bureau of Political-Military Affairs, "U.S. Arms Sales and Defense Trade," webpage, January 20, 2021. As of September 26, 2022: https://www.state.gov/u-s-arms-sales-and-defense-trade/
174	International Traffic in Arms Regulations (ITAR)	State	U.S. Department of State, Directorate of Defense Trade Controls, "The International Traffic in Arms Regulations (ITAR)," webpage, undated. As of September 26, 2022: https://www.pmddtc.state.gov/?id=ddtc_kb_article_ page&sys_id=%2024d528fddbfc930044f9ff621f961987
175	Missile Technology Control Regime (MCTR): Export Controls (Guidelines & MCTR Annex), Meetings, and Dialogue & Outreach	State	U.S. Department of State, Bureau of International Security and Nonproliferation, "Missile Technology Control Regime (MTCR) Frequently Asked Questions," webpage, undated. As of September 26, 2022: https://www.state.gov/remarks-and-releases-bureau-of-inte rnational-security-and-nonproliferation/missile-technolog y-control-regime-mtcr-frequently-asked-questions/
176	Overseas Security Advisory Council (OSAC)	State	U.S. Department of State, "Overseas Security Advisory Council," webpage, undated. As of September 26, 2022: https://www.state.gov/overseas-security-advisory-council/
177	Part 130 Decision Tree Tool	State	U.S. Department of State, Directorate of Defense Trade Controls, "Part 130 Decision Tree Tool," webpage, undated. As of September 26, 2022: https://www.pmddtc.state.gov/ddtc_public?id=ddtc_public_ portal_dt_part_130
178	Specially Designed Decision Tool	State	U.S. Department of State, Directorate of Defense Trade Controls, "Specially Designed Decision Tool," webpage, undated. As of September 26, 2022: https://www.pmddtc.state.gov/ddtc_public?id=ddtc_public_ portal_dt_specially_designed

Table C.1—continued

No.	Approach Name	Agency	References
179	Statutory Debarment	State	U.S. Department of State, "Statutory Debarment Under the Arms Export Control Act and the International Traffic in Arms Regulations," Public Notice 11118, *Federal Register*, Vol. 85, No. 98, May 20, 2020, pp. 30783–30784. As of September 26, 2022: https://www.federalregister.gov/documents/2020/05/20/2020-10862/statutory-debarment-under-the-arms-export-control-act-and-the-international-traffic-in-arms
181	US Munitions List (USML)	State	Code of Federal Regulations, Title 22—Foreign Relations, Chapter I—Department of State, Subchapter M—International Traffic in Arms Regulations, Part 121—The United States Munitions List.
182	USML Order of Review Decision Tool	State	U.S. Department of State, Directorate of Defense Trade Controls, "Order of Review Decision Tool," webpage, undated. As of September 26, 2022: https://www.pmddtc.state.gov/ddtc_public?id=ddtc_public_portal_dt_order_of_review
183	Visa Fraud Prevention	State	U.S. Department of State, Bureau of Diplomatic Security, "Passport and Visa Fraud," webpage, undated. As of September 26, 2022: https://www.state.gov/passport-and-visa-fraud/
184	311 Actions	Treasury	U.S. Department of the Treasury, "311 Actions," webpage, undated. As of September 26, 2022: https://home.treasury.gov/policy-issues/terrorism-and-illicit-finance/311-actions
185	Committee on Foreign Investment in the United States (CFIUS) review	Treasury	U.S. Department of the Treasury, "The Committee on Foreign Investment in the United States (CFIUS)," webpage, undated. As of November 28, 2022: https://home.treasury.gov/policy-issues/international/the-committee-on-foreign-investment-in-the-united-states-cfius
186	Research and Experimentation Tax Incentives	Treasury	Internal Revenue Service, *Instructions for Form 6765: Credit for Increasing Research Activities*, revised January 2022. As of September 26, 2022: https://www.irs.gov/pub/irs-pdf/i6765.pdf
187	Office of Foreign Assets Control (OFAC) sanctions programs and designations	Treasury	U.S. Department of the Treasury, "Office of Foreign Assets Control—Sanctions Programs and Information," webpage, undated. As of September 26, 2022: https://home.treasury.gov/policy-issues/office-of-foreign-assets-control-sanctions-programs-and-information
188	Small Business Lending Fund (SBLF)	Treasury	U.S. Department of the Treasury, "Small Business Lending Fund," webpage, undated. As of September 26, 2022: https://home.treasury.gov/policy-issues/small-business-programs/small-business-lending-fund

Table C.1—continued

No.	Approach Name	Agency	References
189	State Small Business Credit Initiative (SSBCI)	Treasury	U.S. Department of the Treasury, "State Small Business Credit Initiative (SSBCI)," webpage, undated. As of September 26, 2022: https://www.treasury.gov/resource-center/sb-programs/Pages/ssbci.aspx
190	Terrorism and Financial Intelligence (TFI) authorities	Treasury	U.S. Department of the Treasury, "Terrorism and Financial Intelligence," webpage, undated. As of September 26, 2022: https://home.treasury.gov/about/offices/terrorism-and-financial-intelligence
191	Various emergency relief measures	Treasury	U.S. Department of the Treasury, Office of the Inspector General, "Management and Performance Challenges Facing the Department of the Treasury," information memorandum from Richard K. Delmar, Deputy Inspector General, to Secretary of the Treasury Steven T. Mnuchin, October 29, 2020. As of September 26, 2022: https://oig.treasury.gov/sites/oig/files/2021-01/OIG-CA-21-006.pdf
192	Work Opportunity Tax Credit	Treasury	Internal Revenue Service, "Work Opportunity Tax Credit," webpage, undated. As of September 26, 2022: https://www.irs.gov/businesses/small-businesses-self-employed/work-opportunity-tax-credit
301	Advanced Manufacturing Office	Energy	U.S. Department of Energy, Office of Efficient and Renewable Energy, "Advanced Manufacturing Office," webpage, undated. As of September 26, 2022: https://www.energy.gov/eere/amo/advanced-manufacturing-office
401	"Special 301" Report	Commerce	Office of the U.S. Trade Representative, "Special 301," webpage, undated. As of September 26, 2022: https://ustr.gov/issue-areas/intellectual-property/Special-301
402	Emerging And foundational Technologies List (under development)	Commerce	U.S. Department of Commerce, Bureau of Industry and Security, "Identification and Review of Controls for Certain Foundational Technologies," *Federal Register*, Vol. 85, No. 167, August 27, 2020, pp. 52934–52935. As of September 23, 2022: https://www.federalregister.gov/documents/2020/08/27/2020-18910/identification-and-review-of-controls-for-certain-foundational-technologies
403	Pilot Programs	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
404	Workforce policy and competency models	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
406	American Spaces	State	U.S. Department of State, *American Spaces Handbook*, webpage, undated. As of September 23, 2022: https://americanspaces.state.gov/managing-your-space/american-spaces-handbook/

Table C.1—continued

No.	Approach Name	Agency	References
407	Artificial Intelligence & Technology Office	Energy	U.S. Department of Energy, Artificial Intelligence and Technology Office, homepage, undated. As of September 26, 2022: https://www.energy.gov/ai/artificial-intelligenc e-technology-office
409	Center for Commercialization of Advanced Technology	Defense	San Diego State University, "Center for Commercialization of Advanced Technology," webpage, undated. As of November 28, 2022: https://lavincenter.sdsu.edu/programs/ccat
410	Centers of Excellence	Defense	Chief Digital and Artificial Intelligence Office, "GSA Centers of Excellence to Support Development, Rollout of the JCF," blog post, February 6, 2020. As of November 28, 2022: https://www.ai.mil/blog_02_06_20-GSA-centers-o f-excellence-to-support-jcf.html
411	Controlled Unclassified Information	Defense	Defense Counterintelligence and Security Agency, "Controlled Unclassified Information," webpage, undated. As of September 26, 2022: https://www.dcsa.mil/mc/ctp/cui/
412	Corporate counterintelligence	IC	Office of the National Counterintelligence Executive, *Protecting Key Assets: A Corporate Counterintelligence Guide*, undated. As of September 26, 2022: https://www.odni.gov/files/NCSC/documents/Regulations/ ProtectingKeyAssets_CorporateCIGuide.pdf
413	Covered Defense Information	Defense	U.S. Department of Defense, "Safeguarding Covered Defense Information—The Basics," undated. As of September 26, 2022: https://business.defense.gov/Portals/57/Safeguarding%20 Covered%20Defense%20Information%20-%20The%20 Basics.pdf
414	Defense Digital Service	Defense	Defense Digital Service, homepage, undated. As of September 26, 2022: https://www.dds.mil
415	Defense Enterprise Science Initiative (DESI)	Defense	Office of the Under Secretary of Defense for Research and Engineering, Basic Research Office, homepage, undated. As of November 28, 2022: https://basicresearch.defense.gov/
416	DIB roundtables, reports, and recommendations	Defense	Defense Innovation Board, "Defense Innovation Board's AI Principles Project," webpage, undated. As of September 26, 2022: https://innovation.defense.gov/ai/
417	Diplomatic Demarches	State	U.S. Department of State, "5 FAH-1 H-600 Diplomatic Notes, 5 FAH-1 H-610 Using Diplomatic Notes," webpage, undated. As of September 26, 2022: https://fam.state.gov/fam/05fah01/05fah010610.html#H613

Table C.1—continued

No.	Approach Name	Agency	References
418	Domestic Preparedness Support Initiative	Defense	Under Secretary of Defense for Policy, "Domestic Preparedness Support Initiative," webpage, undated. As of November 28, 2022: https://policy.defense.gov/OUSDP-Offices/ASD-for-Homeland-Defense-and-Hemispheric-Affairs/Domestic-Preparedness-Support-Initiative/
419	Economic Adjustment Assistance grants	Commerce	U.S. Department of Commerce, U.S. Economic Development Administration, "Economic Adjustment Assistance Program," undated. As of September 26, 2022: https://www.eda.gov/pdf/about/Economic-Adjustment-Assistance-Program-1-Pager.pdf
420	Educate and train senior leaders in critical and emerging tech	Defense	Defense Innovation Board, "Practices and Operations—Recommendation 16—Establish Technology and Innovation Training Program for DoD Senior Leaders," undated. As of September 26, 2022: https://innovation.defense.gov/recommendations/
421	Electromagnetic Spectrum Operations (EMSO) Cross Functional Team (CFT)	Defense	U.S. Department of Defense, "Department Prioritizes Electromagnetic Spectrum Superiority, Implementing 2020 Strategy," press release, August 5, 2021. As of November 28, 2022: https://www.defense.gov/News/Releases/Release/Article/2721086/department-prioritizes-electromagnetic-spectrum-superiority-implementing-2020-s/
422	Energy I-Corps	Energy	U.S. Department of Defense, Office of Technology Transitions, "Energy I-Corps," webpage, undated. As of September 26, 2022: https://energyicorps.energy.gov
423	Export Solutions	Commerce	U.S. Department of Commerce, International Trade Organization, "Export Solutions," webpage, undated. As of September 26, 2022: https://www.trade.gov/export-solutions
424	Federal Laboratory Consortium Tech Transfer	Other	Federal Laboratory Consortium for Technology Transfer, homepage, undated. As of September 26, 2022: https://federallabs.org
425	Financial Sector Innovation Policy Roundtable	Treasury	U.S. Department of the Treasury, "U.S. Treasury Department Holds Financial Sector Innovation Policy Roundtable," press release, February 10, 2021. As of September 26, 2022: https://home.treasury.gov/news/press-releases/jy0023
426	Global Market Trends and Non-Notified CFIUS Cases	Defense	U.S. Department of the Treasury," CFIUS Monitoring and Enforcement," webpage, undated. As of November 28, 2022: https://home.treasury.gov/policy-issues/international/the-committee-on-foreign-investment-in-the-united-states-cfius/cfius-monitoring-and-enforcement
427	HSARPA	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Homeland Security Advanced Research Projects Agency," webpage, undated. As of September 26, 2022: https://www.dhs.gov/science-and-technology/hsarpa

Table C.1—continued

No.	Approach Name	Agency	References
428	Innovation Roundtables	State	U.S. Department of State, "Innovation Roundtables," webpage, undated. As of September 26, 2022: https://www.state.gov/innovation-roundtables/
429	InnovationXLab	Energy	U.S. department of Energy, Office of Technology Transitions, "InnovationXLab Summits," webpage, undated. As of September 26, 2022: https://www.energy.gov/technologytransitions/initiatives/innovationxlab
430	In-STeP	IC	Officer of the Director of National Intelligence, "In-STeP: The Intelligence Science & Technology Partnership," webpage, undated. As of September 26, 2022: https://www.odni.gov/index.php/who-we-are/organizations/policy-capabilities/in-step-the-intelligence-scienc e-technology-partnership
431	International Atomic Energy Agency safeguards	State	U.S. department of State, Bureau of International Security and Nonproliferation, "The International Atomic Energy Agency," webpage, undated. As of September 26, 2022: https://www.state.gov/iaea/
432	International Fulbright Science & Technology Award	State	U.S. Department of State, Bureau of Educational and Cultural Affairs, "International Fulbright Science & Technology Award," webpage, undated. As of September 26, 2022: https://eca.state.gov/fulbright/fulbright-programs/program-summaries/international-fulbright-scienc e-technology-award
433	Joint Science and Technology Funds [replace U.S.-Israel Binational IR&D Foundation]	State	U.S. Department of State, Office of Science and technology Cooperation, "Key Topics," webpage, undated. As of September 26, 2022: https://www.state.gov/key-topics-office-of-science-an d-technology-cooperation/
434	Manufacturing USA partnerships	Unknown	Manufacturing USA, homepage, undated. As of November 28, 2022: https://www.manufacturingusa.com/
435	National Insider Threat Task Force	IC	Office of the Director of National Intelligence, "National Insider Threat Task Force (NITTF) Mission," webpage, undated. As of September 26, 2022: https://www.dni.gov/index.php/ncsc-how-we-work/ncsc-nittf
436	NATO Science and Technology Organization	NATO	North Atlantic Treaty Organization, "Science and Technology Organization," webpage, undated. As of September 26, 2022: https://www.nato.int/cps/en/natohq/topics_88745.htm
437	NIST research labs	Commerce	U.S. Department of Commerce, "Information Technology Laboratory (ITL)," webpage, last updated 2016. As of September 26, 2022: https://2014-2017.commerce.gov/locations/informatio n-technology-laboratory-itl.html#15/39.1402/-77.2185
439	Prioritize K–12 education in fields related to critical and emerging tech	Education, state depts of education	Education Commission of the States, "Vital Signs Notes and Resources," webpage, undated. As of September 26, 2022: https://www.ecs.org/vital-signs-notes-and-sources/

Table C.1—continued

No.	Approach Name	Agency	References
440	Private Sector Office	DHS	U.S. Department of Homeland Security, "Private Sector Office," webpage, undated. As of September 26, 2022: https://www.dhs.gov/private-sector-office
441	Public-Private Consortia	Energy	U.S. Department of Energy, *Quadrennial Technology Review 2015*, Chapter 6: Innovating Clean Energy Technologies in Advanced Manufacturing—Supplemental Information, 2015. As of September 26, 2022: https://www.energy.gov/sites/prod/files/2017/02/f34/Ch6-SI-Public-Private-Consortia-and-Technology-Transition-Case-Studies.pdf
442	Roadmaps	Defense	Defense Logistics Agency, *The Innovator: DLA'S Research & Development Newsletter*, Vol. 4, No. 4, September–October 2018. As of September 26, 2022: https://media.defense.gov/2018/Oct/09/2002049294/-1/-1/1/J68_RD_NEWSLETTER_VOL4_ISSUE4%20SEP-OCT%202018.PDF
443	Science and Technology Agreements	State	U.S. Department of State, Office of Science and Technology Cooperation, "Key Topics," webpage, undated. As of September 26, 2022: https://www.state.gov/key-topics-office-of-science-and-technology-cooperation/
444	Science and Technology Centers of Excellence	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Welcome to the Centers of Excellence," webpage, undated. As of September 26, 2022: https://www.dhs.gov/science-and-technology/centers-excellence
445	Import Actions (Section 232 Investigation)	Commerce	U.S. Department of Commerce, Bureau of Industry and Security, "Section 232 Investigations: The Effect of Imports on the National Security," webpage, undated. As of September 26, 2022: https://www.bis.doc.gov/index.php/other-areas/office-of-technology-evaluation-ote/section-232-investigations
446	Business Acceleration	Commerce	U.S. Economic Development Administration, "EDA Programs," webpage, undated. As of November 28, 2022: https://eda.gov/programs/eda-programs/
447	SelectUSA	Commerce	SelectUSA, "About Us," webpage, undated. As of September 26, 2022: https://www.selectusa.gov/about-selectusa
448	STEM OPT	DHS	U.S. Department of Homeland Security, "STEM OPT Hub," webpage, undated. As of September 26, 2022: https://studyinthestates.dhs.gov/stem-opt-hub
449	STIX: Science, Technology, and Innovation Exchange	Defense	Office of the Under Secretary of Defense for Research and Engineering, Basic Research Directorate, "STI[X]: Science, Technology, and Innovation Exchange," webpage, undated. As of September 26, 2022: https://basicresearch.defense.gov/events/STIX-2018/

Table C.1—continued

No.	Approach Name	Agency	References
450	Strengthen cleared defense contractor reporting	Defense	Office of the Director of National Intelligence, *Foreign Spies Stealing US Economic Secrets: Report to Congress on Foreign Economic Collection and Industrial Sabotage, 2009–2011*, October 2011. As of September 26, 2022*:* https://www.odni.gov/files/NCSC/documents/Regulations/Foreign_Economic_Collection_2011.pdf
451	Tech Demos	State	U.S. Department of State, Technology Engagement Team, "Events—Technology Engagement Team," webpage, undated. As of September 26, 2022: https://www.state.gov/upcoming-events-technology-engagement-team
452	Technology Clearinghouse	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Technology Clearinghouse Overview," undated. As of September 26, 2022: https://www.dhs.gov/sites/default/files/publications/technology_clearinghouse_fact_sheet_12.8.20.pdf
453	Technology Commercialization Fund	Energy	U.S. Department of Energy, Office of Technology Transitions, "Technology Commercialization Fund," webpage, undated. As of September 26, 2022: https://www.energy.gov/technologytransitions/initiatives/technology-commercialization-fund
454	Technology Transfer	Energy	U.S. Department of Energy, Office of Technology Transitions, "Office of Technology Transitions Launches EPIC Prize Round 2," webpage, undated. As of September 26, 2022: https://www.energy.gov/technologytransitions/office-technology-transitions
455	U.S. International Development Finance Corporation	Other	U.S. International Development Finance Corporation, "Our Products," webpage, undated. As of September 26, 2022: https://www.dfc.gov/what-we-offer/our-products
456	U.S.-China Comprehensive Economic Dialogue	Treasury	U.S. Department of the Treasury, "U.S.-China Comprehensive Economic Dialogue," webpage, undated. As of September 26, 2022: https://home.treasury.gov/policy-issues/international/us-china-comprehensive-economic-dialogue
457	University programs	DHS	U.S. Department of Homeland Security, Science and Technology Directorate, "Office of University Programs," webpage, undated. As of September 26, 2022: https://www.dhs.gov/science-and-technology/office-university-programs
458	Unsolicited proposals	DHS	U.S. Department of Homeland Security, "Unsolicited Proposals," webpage, undated. As of September 26, 2022: https://www.dhs.gov/unsolicited-proposals
459	Venture Challenge, Capital Challenge, Industry Challenge	Commerce	U.S. Department of Commerce, U.S. Economic Development Administration, "Build to Scale (B2S) Program," webpage, undated. As of September 26, 2022: https://www.eda.gov/oie/buildtoscale/

Table C.1—continued

No.	Approach Name	Agency	References
461	Develop Policy through DoDIs and Directive-type Memoranda (DTMs)	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
462	DoD Domestic Technology Transfer Program	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
463	Establish strategic priorities and issues guidance	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
464	Inform and influence requirements and CONOPs	Defense	Department of Defense Directive 5137.02, *Under Secretary of Defense for Research and Engineering (USD[R&E])*, July 15, 2020.
465	Securities and exchange listing and disclosure standards	SEC	U.S. Securities and Exchange Commission, "Listing Standards," webpage, undated. As of September 26, 2022: https://www.sec.gov/smallbusiness/goingpublic/listingstandards
500	Joint Concepts Technology Demonstration Program	Defense	Rick Gallman, "Introduction to Joint Capabilities technology Demonstrations (JCTD)," Defense Acquisition University, briefing slides, July 11, 2018, As of September 236, 2022: https://www.dau.edu/Lists/Events/Attachments/109/07-11-2018%20JCTD_RGallman.pdf
501	Information Analysis Centers	Defense	Department of Defense Information Analysis Centers, "About Us," webpage, undated. As of September 26, 2022: https://dodiac.dtic.mil/about-us/
502	NASA Technology Transfer	NASA	National Aeronautics and Space Administration, "NASA's Technology Transfer Program," webpage, undated. As of September 26, 2022: https://technology.nasa.gov
503	Defense Acquisition Challenge Program	Defense	U.S. Code, Title 10—Armed Forces, Subtitle A—General Military Law, Part V—Acquisition, Subpart E—Research and Engineering, Chapter 303—Research and Engineering Activities, Subchapter I—General, Section 4062—Defense Acquisition Challenge Program.
504	Foreign Comparative Testing	Defense	Under Secretary of Defense for Research and Engineering, "Foreign Competitive Testing," webpage, undated. As of September 26, 2022: https://ac.cto.mil/pe/fct/

Reading Guide for the Approach Overviews

This appendix contains a guide to reading the overviews on each researched approach that can be found in the P&P Tool. These overviews provide additional information about each approach and are crafted to help the tool user evaluate an approach, locate additional information about the approach, and understand how the approach was coded in the tool. The overviews follow a uniform structure, including the following sections:

1. A brief introduction to the approach
2. A table summarizing key elements of approach coding (Table 1)
3. Stated goals/objectives of approach
4. A table identifying key targets of the approach (Table 2)
5. Risks, issues, or opportunities
6. Preconditions
7. Approach process
   a. Steps involved in execution
   b. Implementation timeframe
   c. Industrial base/target partner
   d. Timeframe to request assistance
   e. Entry requirements, security requirements, workforce qualifications, and IP restrictions
   f. Color of money
   g. Funding source
   h. Congressional action required to implement
   i. Recommended practices
   j. Measures of success
   k. Limits and downsides of approach use
8. Example of approach's use
9. Use Guidance/Frequently Asked Questions
10. Abbreviations.

The remainder of this appendix provides an explanation of each section of the approach overview.

Introduction

The introduction briefly summarizes the approach and illustrates ways DoD may use the approach to promote and/or protect technology.

Table 1. Overview of Approach Coding

Table 1 documents coded values/findings for seven key attributes of the approach:

- Type of Approach: protection/promotion and investment/non-investment.
- NSIB Improvement Area: improvement(s) to the National Security Innovation Base that the approach may be used to achieve (details in Chapter 4 under section for "Adding an Approach").
- Course of Action: the action(s) taken to improve the National Security Innovation Base through use of the approach (details Chapter 4 under section for "Adding an Approach").
- Agency/Office: the primary entity responsible for administering the approach.
- Website: the official, public website concerning the approach.
- Point of Contact: a liaison for further information about the approach.
- Derivative/Related Programs: identifies any additional entities that administer or execute an equivalent approach (e.g., derivative name, shared mission, shared goals/objectives).

Documented goals and/or objectives of the approach immediately follow Table 1.

Table 2. Approach Targets

Table 2 identifies specific focuses of the approach by coded values/findings along seven key technology/market attributes:

- Targeted Technology/Industry: the type(s) of technology or industry to which the approach is designed to apply.
- TRL Requirements: if applicable, the Technology Readiness Level at which a technology must be upon entering use the approach (TRL at entry) and the TRL to which the approach is designed to raise the technology (TRL at exit). See TRL definitions in Chapter 4 under "Adding an Approach."
- MRL Requirements: if applicable, the Manufacturing Readiness Level at which a technology must be upon entering use the approach (MRL at entry) and the MRL to which the approach is designed to raise the technology (MRL at exit). See MRL definitions in Chapter 4 under "Adding an Approach."

- Program/Life-Cycle Phase: the DoD acquisition phase(s) for which the approach applies. Major Capability Acquisition phases are Material Solutions Analysis (MSA), Technology Maturation and Risk Reduction (TMRR), Engineering and Manufacturing Development (EMD), Production and Deployment (P&D), and Operations and Support (O&S).
- Existing Technology/Service/Process Applications: The current end-use market for applications of the technology/service/process, for which the approach can be utilized.
- Existing Market Demand Concentration: For a technology/service/process with a dual-use application, the Existing Market Demand Concentration indicates where the majority of demand can be located in order to use an approach.
- Targeted to Software?: indicates whether the approach primarily applies to software.

Risks, Issues, or Opportunities

This section identifies risks, issues, and/or opportunities that are external to the approach, but that the approach is designed to mitigate, manage, or exploit. Risks, issues, and opportunities are generally derived from the *Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs* (DoD, 2017).

Preconditions

Preconditions are necessary conditions that are exclusive of the approach but must be in place for the approach to be used (e.g., an existing program distinct from the approach, a national security justification).

Approach Process

The Approach Process section presents several subsections with information about how the approach may be used.

Steps Involved in Execution
Steps involved in executing approaches vary by complexity, the number of parties involved, and the responsibilities of each party. This subsection broadly summarizes the steps involved in executing the approach and identifies key parties along with their responsibilities.

Implementation Timeframe
The implementation timeframe describes how long the approach takes from the time it is initiated to the time it is completed.

Industrial Base/Target Partner

The industrial base partner or target partner is the party, external to DoD, for whom the approach is designed to assist.

Timeframe to Request Assistance

Timeframe to request assistance specifies when the approach may be initiated, including whether pre-initiation consultation or coordination is available.

Entry Requirements, Security Requirements, Workforce Qualifications, and IP Restrictions

This subsection details several requirements and restrictions that may be involved when executing the approach:

- Entry Requirements: criteria upon which an industrial base/target partner or targeted technology/service/process is judged suitable for the approach.
- Security Requirements: personnel, facility, or other industrial security conditions that parties involved in executing the approach must meet.
- Workforce Qualifications: requirements that a certain number and/or qualification of personnel be employed or otherwise involved in the approach's execution.
- Intellectual Property (IP) Restrictions: conditions imposed or invoked to clarify intellectual property rights, responsibilities, and relationships among parties involved in executing the approach.

Color of Money

"Color of money" refers to the defense appropriation category necessary for executing the approach. Defense appropriation categories include Research, Development, Test and Evaluation (RDT&E), Procurement, Operations and Maintenance (O&M), Military Personnel (MILPERS), and Military Construction (MILCON). According to DAU ("Types of Funds," webpage, undated):

- "RDT&E appropriation accounts generally finance research, development, test and evaluation efforts performed by contractors and government installations to develop equipment, material, or computer application software; its Development Test and Evaluation (DT&E); and its Initial Operational Test and Evaluation (IOT&E)." (DAU, undated, webpage)
- "Procurement appropriations are used to finance investment items and should cover all costs necessary to deliver a useful end item intended for operational use or inventory [e.g., shipbuilding and conversion, aircraft procurement, missile procurement]." (DAU, undated, webpage)

- "O&M appropriations traditionally do not finance investments, but rather those things whose benefits are derived for a limited period of time, i.e., expenses." (DAU, undated, webpage)
- "MILPERS appropriations are used to fund the costs of salaries and compensation for active military and National Guard personnel as well as personnel-related expenses . . ." (DAU, undated, webpage)
- "MILCON appropriation accounts … are enacted separately from the Defense Appropriations Act [. . . and . . .] fund the costs of major construction projects such as bases, facilities, military schools, etc." (DAU, undated, webpage)

Funding Source

If the approach involves an investment or expenditure, funding source identifies the primary entity or entities responsible for funding the approach's use.

Congressional Action Required to Implement

This subsection documents congressional action required to implement the approach, such as congressional review or authorization. However, because congressional appropriations are nearly always required, appropriations are only specified if the approach requires an unusual appropriation such as reinstated funding.

Recommended Practices

Recommended practices for executing the approach are compiled from documentation reviewed and discussion with key stakeholders and subject matter experts.

Measures of Success

Measures of success are indicators used to assess or evaluate the approach's performance in achieving its stated goals and/or objectives. These indicators are compiled from documentation reviewed and discussion with key stakeholders and subject matter experts.

Limits and Downsides of Approach Use

This subsection lists notable limits and potential downsides of using the approach. Specific limits and downsides listed are relevant in the context of promoting or protecting critical and emerging technology. The limits and downsides are compiled from documentation reviewed and discussion with key stakeholders and subject matter experts.

Example of Approach's Use

To help convey potential applications and implications of using the approach, an inset box includes an example of the approach's use in practice. Examples are selected based on publicly available documentation, insight into approach complexities, and relevance to promoting or protecting critical and emerging technology.

Use Guidance/Frequently Asked Questions

This subsection contains a limited sample of references from the documentation reviewed, selected to provide the user with accessible resources for further inquiry. This sample includes guidance and authorities applicable to executing the approach, and as available, frequently asked questions about the approach and published by the approach agency/office.

Abbreviations

This table defines abbreviations used more than once throughout the overview.

Abbreviations

C&ET	critical and emerging technology
CFIUS	Committee on Foreign Investment in the United States
COA	course of action
DARPA	Defense Advanced Research Projects Agency
DAU	Defense Acquisition University
DIU	Defense Innovation Unit
DoD	U.S. Department of Defense
DoDI	Department of Defense Instruction
FBI	Federal Bureau of Investigation
FFRDC	federally funded research and development center
GAO	U.S. Government Accountability Office
IP	intellectual property
M&A	mergers and acquisitions
MILCON	Military Construction
MILPERS	Military Personnel
MRL	manufacturing readiness level
MURI	Multidisciplinary University Research Initiative
NIST SP	National Institute of Standards and Technology Special Publication
NSIB	National Security Innovation Base
NSSL	National Security Space Launch
O&M	Operations and Maintenance
OSD	Office of the Secretary of Defense
P&P	Promotion and Protection
PPP	public-private partnership
R&D	research and development
RDT&E	Research, Development, Test, and Evaluation
SBA	Small Business Administration
SBIC	Small Business Investment Company
SME	subject-matter expert
S&T	science and technology
STP&E	Strategic Technology Protection and Exploitation
TRL	technology readiness level
U.S.C.	U.S. Code
VBA	Visual Basic for Applications

References

DAU—*See* Defense Acquisition University.

Defense Acquisition University, "Types of Funds, Glossary Definitions," webpage, undated. As of September 6, 2022:
https://www.dau.edu/acquipedia/pages/articledetails.aspx#!246

Department of Defense Instruction 5000.83, *Technology and Program Protection to Maintain Technological Advantage*, U.S. Department of Defense, July 20, 2020, incorporating Change 1, effective May 21, 2021. As of September 6, 2022:
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500083p.pdf

Department of Defense Instruction 5010.44, *Intellectual Property (IP) Acquisitions and Licensing*, U.S. Department of Defense, October 16, 2019. As of September 6, 2022:
https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/501044p.PDF

Defense Innovation Unit, *Annual Report 2020*, 2020. As of September 6, 2022:
https://assets.ctfassets.net/3nanhbfkr0pc/3VXak4123q9HHoG2rvpQFO/385542158e5b6ca62e7fa63c03bcfe0d/DIU_-_2020_Annual_Report_FINAL.pdf

DoD—*See* U.S. Department of Defense.

DoDI—*See* Department of Defense Instruction.

GAO—*See* U.S. Government Accountability Office.

National Research Council, *International Friction and Cooperation in High-Technology Development and Trade: Papers and Proceedings*, Washington, D.C.: National Academies Press, 1997.

Office of the Secretary of Defense Manufacturing Technology Program, *Manufacturing Readiness Level (MRL) Deskbook*, Version 2020, 2020. As of September 6, 2022:
https://www.dodmrl.com/MRL%20Deskbook%20V2020.pdf

Organisation for Economic Co-operation and Development, "Science, Technology, and Innovation Policy Compass," website, 2021. As of September 6, 2022:
https://stip.oecd.org/stip/

OSD—*See* Office of the Secretary of Defense.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), "PRISMA Flow Diagram," undated. As of September 6, 2022:
https://prisma-statement.org//prismastatement/flowdiagram.aspx

Small Business Administration, "Contracting Guide: Basic Requirements," webpage, undated. As of September 6, 2022:
https://www.sba.gov/federal-contracting/contracting-guide/basic-requirements

Triezenberg, Bonnie L., Colby Peyton Steiner, Grant Johnson, Jonathan Cham, Eder Sousa, Moon Kim, and Mary Kate Adgie, *Assessing the Impact of U.S. Air Force National Security Space Launch Acquisition Decisions: An Independent Analysis of the Global Heavy Lift Launch Market*, Santa Monica, Calif.: RAND Corporation, RR-4251-AF, 2020. As of September 6, 2022:
https://www.rand.org/pubs/research_reports/RR4251.html

United Nations Educational, Scientific and Cultural Organization, "Global Observatory of Science, Technology and Innovation Policy Instruments," webpage, 2021. As of September 6, 2022:
https://en.unesco.org/go-spin

U.S. Air Force, Technology Transfer and Transition, *Air Force Tech Transfer Handbook*, September 2020. As of September 6, 2022:
https://www.aft3.af.mil/Portals/74/Pages/Publications/AirForce_TechTransfer_Handbook-PACleared-AFRL-2020-0196.pdf

U.S. Department of Defense, *Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs*, January 2017. As of September 6, 2022:
https://acqnotes.com/wp-content/uploads/2017/07/DoD-Risk-Issue-and-Opportunity-Management-Guide-Jan-2017.pdf

U.S. Government Accountability Office, *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects*, GAO-20-48G, 2020.

U.S. Government Accountability Office, *DOD Critical Technologies: Plans for Communicating, Assessing, and Overseeing Protection Efforts Should Be Completed*, GAO-21-158, 2021.

Vermeer, Michael J. D., and Evan D. Peet, *Securing Communications in the Quantum Computing Age: Managing the Risks to Encryption*, Santa Monica, Calif.: RAND Corporation, RR-3102-RC, 2020. As of September 6, 2022:
https://www.rand.org/pubs/research_reports/RR3102.html

The White House, *National Strategy for Critical and Emerging Technologies*, October 2020. As of September 6, 2022:
https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/10/National-Strategy-for-CET.pdf

The White House, *Interim National Security Strategic Guidance*, March 2021. As of September 6, 2022:
https://www.whitehouse.gov/wp-content/uploads/2021/03/NSC-1v2.pdf

RAND NATIONAL DEFENSE RESEARCH INSTITUTE

The U.S. government has developed hundreds of approaches to promote and protect critical technologies and their associated industrial base, and the sheer number and diversity of these programs, policies, and initiatives present a logistical challenge for the U.S. Department of Defense (DoD). Upon discovering a risk or vulnerability to a critical technology, DoD must be able to quickly and effectively determine relevant approaches that can mitigate the problem, and the approaches' related implementation considerations.

To assist DoD in this approach selection, the authors of this report developed a selection framework that (1) identifies relevant approaches based on features of the technology and strategy, (2) provides details on approach implementation considerations, and (3) is instantiated by an interactive tool for use by government entities to inform approach decisionmaking. In this report, they describe the selection framework and provide supporting documentation for the associated tool.

$32.00

9 781977 410498

www.rand.org