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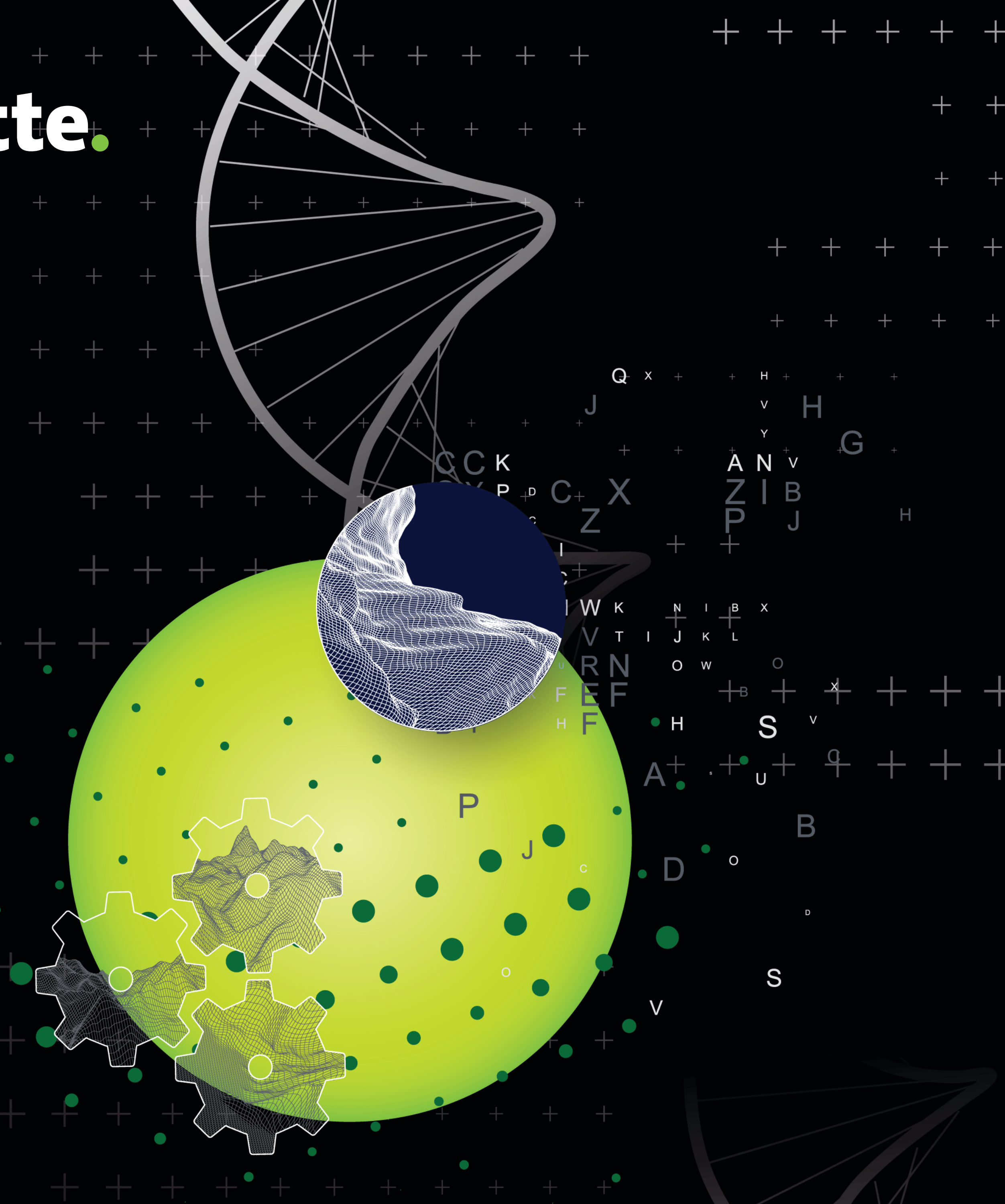

Economic and data perspectives of S&T & R&D portfolio optimization

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Problem statement

Achieving the US National Security objectives is underpinned by the ability to successfully transition Science and Technology (S&T) and Research, Development, Testing, and Evaluation (RDT&E) into programs, affordably and at scale.

The 12- to 20-year Department of Defense (DoD) weapon systems development cycle is the subject of numerous efforts including provisions in the National Defense Authorization Act, think-tank studies, and DoD internal reviews. The national security and national defense strategies link the US' ability to accelerate technology into the deployed force.[i] Therefore, the opportunity to accelerate S&T and RDT&E into programs benefits the DoD in terms of force and economic effectiveness.

Factors identified within the paper to help convert R&D into programs include economic feasibility, technological maturity opportunity/cost trade-offs, and program management. Broader factors include developing the government workforce and gaining buy-in from the industrial base.

Overview

The fighting in the Russia-Ukraine war has demonstrated how legacy Soviet-era systems have combined with rapid modifications and are then employed quickly into the front-line operations. Since 2022, we have seen changes in tactics, techniques, and procedures (TTPs) used by threat actors. These TTPs then employ new, modified, and old systems—including using aerial drones with ordnance over troops in contact.

The war in Ukraine is changing how modern wars are conducted. The war now employs drones, military and commercial satellites with imaging and communications, and missile defense systems.[ii] The use of data, even artificial intelligence, plays an increasingly bigger role integrating the entire battlespace. Moreover, the war has produced a relative tactical stalemate, which becomes fertile ground to bring into the conflict technologies that may historically take five to 20 years to mature. It is important to understand the developmental and transition costs that pull RDT&E into operations and then sustain those systems in forward deployed geographies.

The national security threats from nation states highlight the importance of technological pace and risks of parity in warfare. Near peer threats are leveraging a "system of systems" approach integrated across all domains including geography and robotics to degrade US advantages.[iii] Combatant commands and commanders (COCOMS) are engaging in our most forward geographical countries recognizing the employment by adversaries from competition to conflict.

As technological advancement is increasing and the adoption of new/transformative technologies becomes more prevalent amongst near peer competition, the need for converting research into fielded technologies that can be leveraged on the battlefield is paramount. In 2019 DEVCOM reported that 30% of S&T activities transitioned to a project management office in the Army.[iv] If only 30% are transitioned to a project management office, then 70% or more technologies fall into the infamous "valley of death." The "valley of death" is a colloquialism often used withing the DoD to explain a phenomenon where technologies and research languish and are unable to transition into a DoD military program that becomes acquisition/procurement and not R&D.

Deloitte published two previous papers in 2023 that explored the interaction of price and cost effect on traditional systems acquisition across the RD&A portfolio.[v] The 2nd paper focused on how economic and operations/compliance risk can impact Foreign Military (FMS) accounts.[vi]

FMS is potentially a very strong lever for the DoD and the Defense Industrial Base to increase the conversion of S&T/R&D transition due to the >$100B (Army) portfolio for FMS. The downside is that an S&T pipeline, which has 12-20 years to maturity, can have increased and compounding costs associated with each program. In some cases, this could render a program unaffordable. For example, a 5% cost growth per year would equal to 175%–200% increase from inception estimates.[vii]

The aim of the paper is to put forward the ability to increase the probability of success and persistence across the S&T, RDT&E, and program transition; but, more importantly, increase the probability of transitioning the right technologies.

We highlight the impacts of the current governance structure of S&T programs, look at commercial industries and how they approach R&D, evaluate the cost and financing of S&T within the Planning, Programming, Budgeting, and Execution (PPBE) process, and finally look at the role of data within the S&T process. Additionally, the paper will often differentiate between S&T (a subset of RDT&E that focuses on nascent research and development) and RDT&E.

S&T and R&D successful transition relies on three factors:

a) Timeline relevant to operational demand;

b) Technical maturity and feasibility; and

c) Affordability in procurement and sustainment.

RDT&E in context

According to a Congressional Research Service (CRS) report in FY2022, the DoD accounted for 41.1% of all federal R&D appropriations ($65.7 billion of $159.6 billion in FY2022).[viii] The appropriation that DoD uses to fund R&D activities is the RDT&E appropriation. Additionally, RDT&E accounted for ~16% of total DoD obligational authority in FY22.[ix] RDT&E is a significant percentage of the National Security Strategy in terms of pure dollars and total obligations.

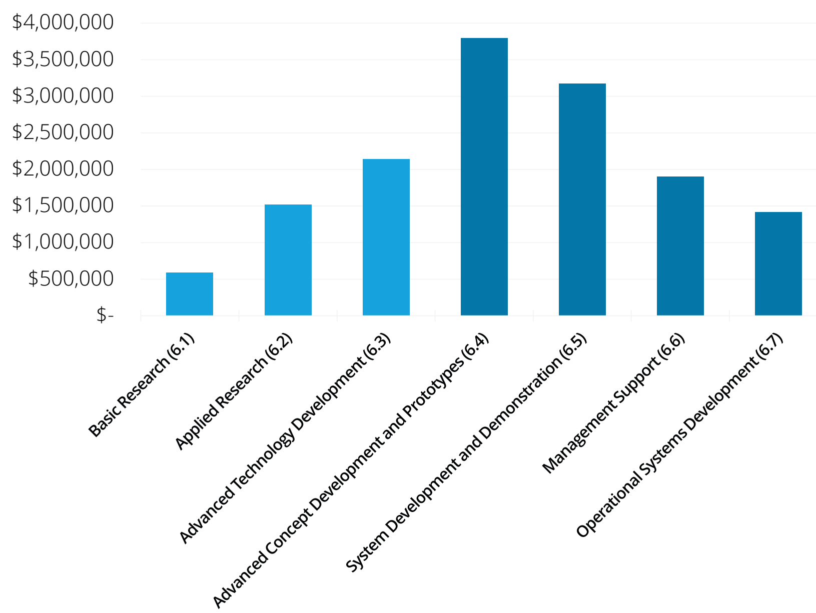
RDT&E "as share" of DoD total obligational authority (TOA) has been up and down. The last five years has seen an increase in RDT&E as a share of TOA from FY17 to FY22. The US investment in RDT&E is directly tied to the threat of near peer competition and the rise of foreign powers and the technological pace of change throughout the world. Additionally, the increased investment in RDT&E since 2017 was due in part to synchronize the S&T/RDT&E pipeline to match the national security and military strategy.[x]

It is also instructive to compare the R&D funding for Aerospace and Defense (A&D) companies as depicted in the graphic below. When looking at publicly available 10K documents, we see that the top six A&D companies by revenue over the last ten years have an R&D percentage of top-line revenue that is relatively stable. So as revenue grows for the top 6 A&D Companies, net R&D spend grows proportionally, whereas DoD R&D percentage is outpacing increase in TOA. We can also compare them proportionally to RDT&E funding in the above graphic. At a high level, it seems that the US government is shouldering more of the burden in R&D for defense related technologies from 2017 to 2022.

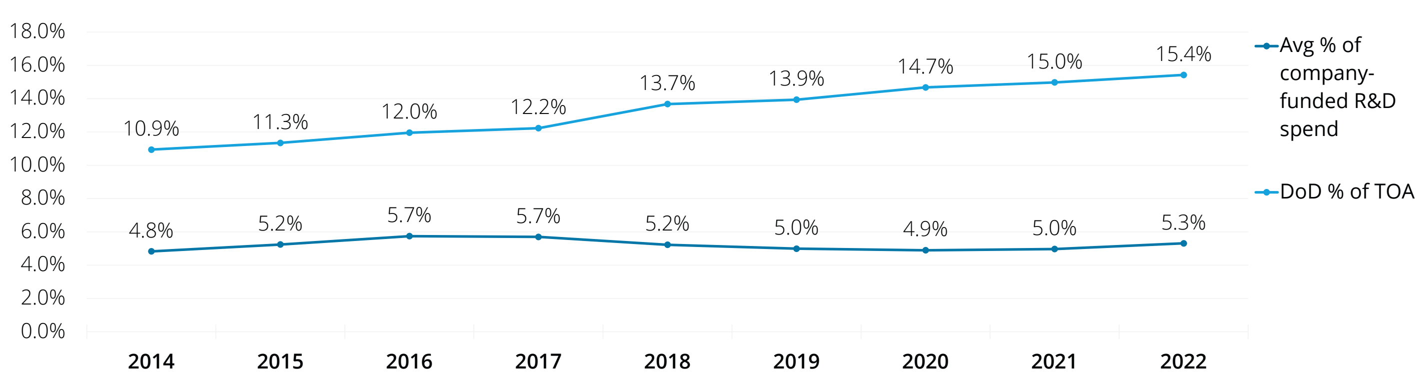
The RDT&E appropriation is broken out into seven separate budget activities. The DoD considers the first three budget activities (6.1-6.3) as S&T and 6.4, 6.5, 6.6, and 6.7 are considered the development, test, and evaluation components. Going from 6.3 to 6.4 is considered where technology transition happens and where the "valley of death" often occurs.

The graph below highlights the funding of activity in the past FY (FY22) which shows the preponderance of funding is in the 6.4, Advanced Concept Development, where technology becomes a program of record.

FY22 RDT&E FUNDING BY RDT&E BUDGET ACTIVITY [xii]



A&D "BIG 6" DEFENSE COMPANIES' REVENUE AS PERCENTAGE OF REVENUE VS. DoD RDT&E SPEND AS PERCENTAGE OF ToA [xi]

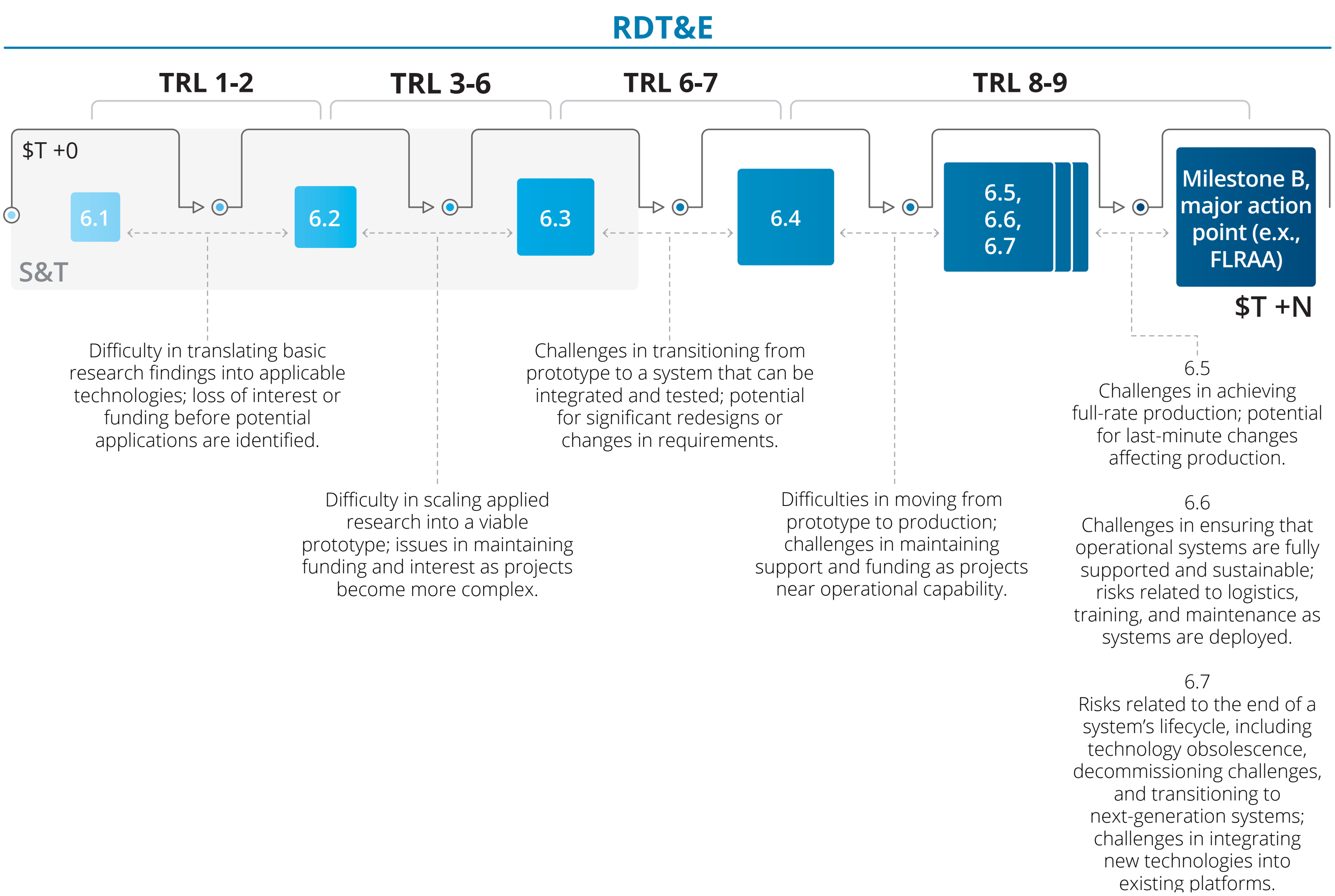


External and internal planning factors create a non-linear path for prototypes and technology to be successfully transitioned to a DoD program. These include market/economic variables such as supply chain and pricing pressures in the economy, risk aversion from the project managers (PMs), and mission requirements. As such, it creates a less efficient pipeline for successful S&T transition where the incentives of various stakeholders, particularly the S&T labs and the PMs, are mismatched.

As the technology transitions between the budget activities the money initially invested (e.g., budget activities 6.1 to 6.2) increases over time due to price and cost factors the longer it stays within S&T and a decision is not made (fielding or killing the research). To move between channels, the cost and overall risk of the technology compounds; inflation is one such factor, but other risk factors include non-standardized data and structure, contracting, design or computational tools, etc.

The process graphic below illustrates the concept from the previous two paragraphs. Transitioning from each budget activity has different risks, and the cost of R&D increases over time. There are also technology readiness levels (TRLs) associated with each budget activity that should be met to be compliant to transition.

Ultimately, to maintain US national security in the interim and long term, the US should invest in research and S&T, but the US should also focus on making sure that the S&T pipeline is synced to the overall R&D pipeline so that technology transition is more successful. The 2023 National Defense S&T Strategy puts it succinctly, "We must take steps to preserve our leadership and counter our competitors who have taken direct aim at this advantage."[xiii]



Governance and process

CURRENT S&T GOVERNANCE PROCESS

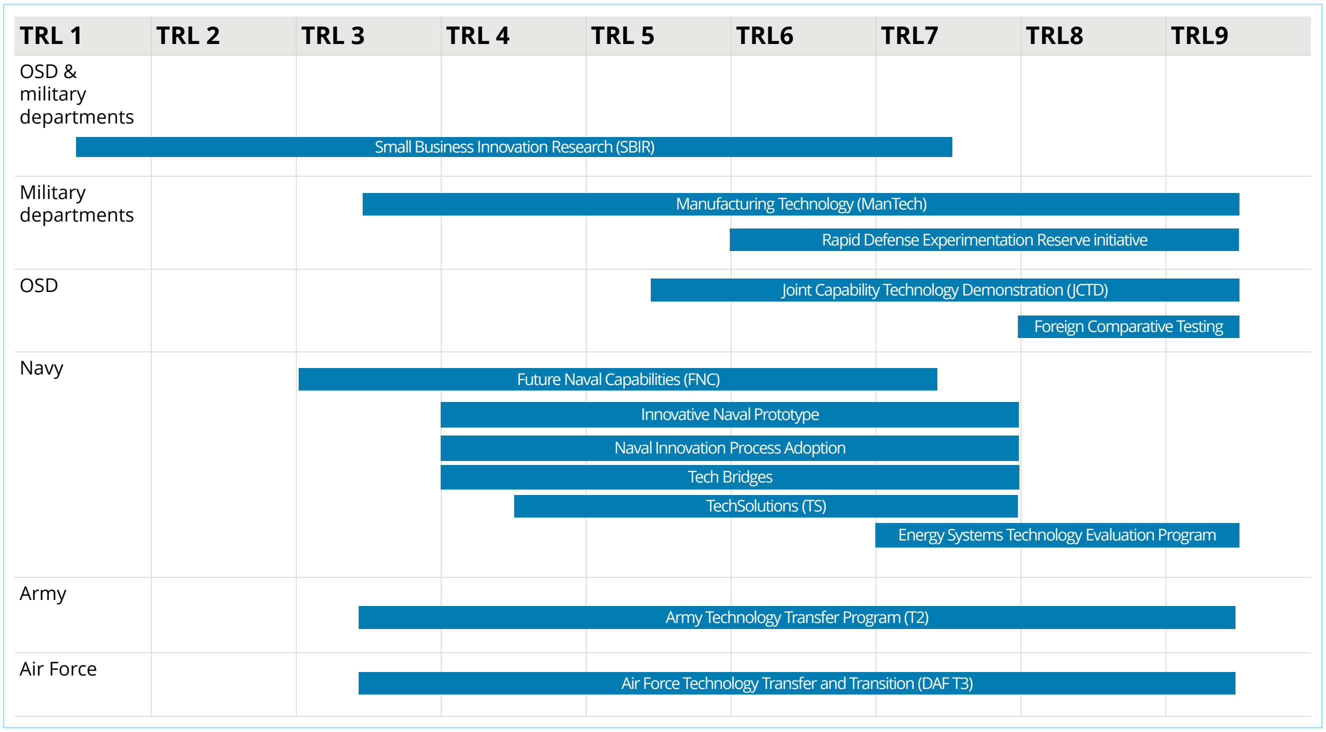
Currently, more than a dozen technology transition initiatives are overseen by the Office of the Secretary of Defense (OSD) and various military departments.[xiv] These programs offer organized methods and financial support to ease the process of transitioning technologies. They uniformly present opportunities for moving technologies from the S&T portfolio to end-users, including weapon system acquisition programs or military personnel in operational environments.

The 2023 National Defense S&T Strategy lays out plans for coordination between the OUSD (R&E) and Under Secretary of Defense Acquisition and Sustainment to "develop new processes, procedures, and forums to drive close collaboration with the Military Services' and OSD acquisition and sustainment communities to spearhead rapid fielding of capabilities at speed and scale."[xv]

In the context of S&T, transition agreements (TAs) and TRLs are crucial for understanding whether that technology development aligns with strategic and operational needs. TAs formalize partnerships between developers and end-users, defining goals, timelines, and responsibilities to streamline the integration of new technologies into defense systems. Concurrently, TRLs provide a standardized framework to evaluate technology maturity, facilitating informed decision-making and resource allocation. Together, these mechanisms are designed to enhance strategic coordination, risk management, and the timely delivery of capabilities, playing a vital role in maintaining the DoD's technological superiority in a dynamic global threat environment.

While reimagining the governance of S&T presents considerable challenges, the cost of inaction can be far greater. Without proactive measures, organizations risk finding themselves with mature R&D outcomes that, due to escalating costs over time, may become increasingly difficult to afford and implement. This scenario could significantly hinder the DoD's capacity to respond promptly to new threats and sustain its technological superiority in a competitive global environment. Therefore, it's imperative to address these governance challenges head-on to make sure that S&T investments yield timely, cost-effective, and strategically-relevant outcomes.

The graphic below depicts representative S&T and Technology Transition programs across OSD and the military departments to illustrate the need for effective and non-duplicative governance structures.



[xvi]

THE NEED FOR EFFECTIVE GOVERNANCE IN S&T

In the context of transitioning S&T efforts to practical applications, the role of governance cannot be overstated. Effective governance acts as a foundational element from the very inception of these initiatives, aiming to guide the transition process with a clear, strategic framework. This involves setting priorities, allocating resources efficiently, and establishing policies and standards that foster innovation while aligning with broader objectives.

By integrating governance early on, stakeholders can navigate complexities and challenges inherent in the transition process more effectively, thereby enhancing the potential for successful integration of new technologies into operational use. This proactive approach contributes to making S&T projects not only visionary but also pragmatic, fostering outcomes that are both innovative and aligned with the needs of end-users, such as weapon systems acquisition programs or military personnel in the field.

Without a well-visioned governance structure, programs can face a lack of cohesive and strategic decision-making processes, ineffective communication channels among stakeholders, and a failure to align S&T initiatives with pressing operational needs and future warfare requirements. This can lead to a suboptimal utilization of resources, resulting in delays, cost overruns, and the inability to rapidly integrate cutting-edge technologies into defense systems.

Moreover, when organizations forgo co-developing governance frameworks with their S&T pipeline, an often-fragmented approach to research and development is observed by leaders, with insufficient collaboration between military, academic, and industry partners.[xvii] This may lead to a disconnect between the development of innovative technologies and their practical application in military contexts, as evidenced by the low conversion rate of S&T projects to operational capabilities.[xviii]

In an era where adversaries rapidly harness new technologies for tactical gains, bureaucratic inertia and inefficient processes within S&T transition pipelines can challenge the United States' responsiveness to emerging threats and its enduring strategic and technological leadership. S&T governance structures are essential to streamline decision-making, foster innovation, and maintain a competitive edge in a fast-evolving global landscape.

GOVERNANCE CHALLENGES IN S&T

Estimating the cost of governance challenges in the DoD S&T transition activities requires a methodical approach to understand the financial impact of misaligned projects and inefficiencies. The framework for this analysis considers the total federal spending in DoD S&T and the percentage of projects that are not aligned with strategic goals or existing programs.

First, consider the total federal spending in DoD S&T. This figure represents the comprehensive budget allocated for science and technology activities within the DoD. For the sake of this analysis, we can assume the total federal spending in DoD S&T for a given fiscal year is set at the FY23 budget request of $16.5 billion.[xix]

Next, determine the percentage of projects that are not aligned with strategic goals or existing programs. This misalignment indicates governance challenges, as it reflects a lack of strategic focus and integration with the DoD's broader objectives and operational needs. Misaligned projects are less likely to transition successfully into operational capabilities, thereby representing inefficiencies and wasted resources. Suppose based on previous GAO estimates of independent R&D projects, that 38% of DoD S&T-related projects are not aligned with strategic goals or existing programs.[xx]

In this example, if the total federal spending in DoD S&T is $16.5 billion and 38% of the projects are not aligned with strategic goals or existing programs, the cost of misaligned spending due to poor governance would be $6.27 billion each fiscal year.

This $6.27 billion represents the financial impact of governance challenges in terms of misaligned S&T projects within the DoD. This figure is a conservative estimate, as it does not account for other potential inefficiencies such as duplicative research efforts, administrative overheads associated with misaligned projects, or the opportunity costs of not investing these resources in more strategically aligned initiatives.

The cost of governance challenges in DoD S&T transition activities can be significant, underscoring the importance of strategic alignment, effective project management, and efficient use of resources to optimize the impact of federal spending in defense-related science and technology. With an increased legislative trend of capping the discretional defense budget authority, understanding these gaps and their associated costs to the US taxpayer is of increasing importance.

R&D lessons from commercial industries

To improve the S&T conversion rate, the DoD can draw insights from commercial R&D governance, commercialization strategy and partnerships that foster innovation, growth, and market competitiveness. Given the fast-paced nature of change and technological development in advanced industries, streamlining the R&D process is just as important as increasing net R&D expenditure to yield results for the stakeholders.

Perhaps no industry is as invested in successful R&D commercialization than the pharmaceutical industry. Between 2000 and 2020, the pharmaceutical industry had the highest average R&D budget as a percentage of net revenues (19%), with the semiconductor, technology hardware, and software industries lagging at an average at 15%.[xxi]

The importance of effective R&D governance is highlighted when looking at the pharmaceutical industry's R&D spend and drug yield. Despite a continuing upward trend in R&D allocation, the industry still faces challenges with negative R&D productivity, suggesting that greater R&D spend may not necessarily result in increased commercialization success rate.[xxii] The R&D success rate from Phase I clinical trials to final approval was consistently approximately 10% over various study periods from 1963 to 2020, and the rate did not increase over the years.[xxiii]

THE STAGE GATE METHOD AND REAL OPTIONS ANALYSIS

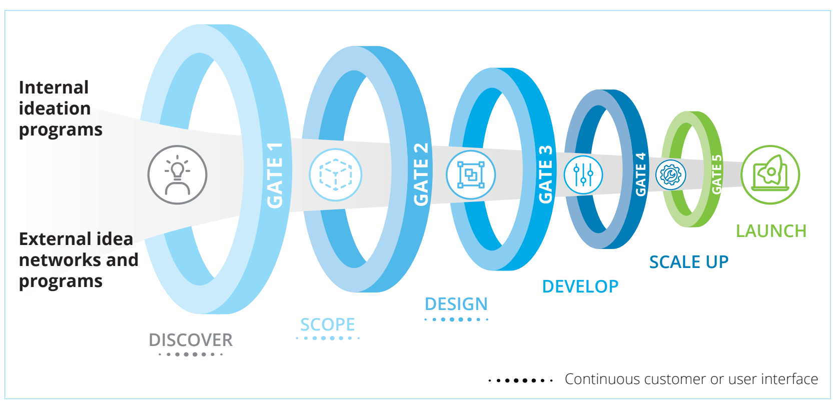
The Stage Gate method, also referred to as phase gate process, is an industrial commercial project management technique that breaks up a project into shorter phases according to milestones, which must be met sequentially to move on to the next milestone.[xxiv] These frequent checkpoints in early stages of development that will determine if a project should be pursued further or not can mitigate long term R&D project risks in two ways.

First, these "gates" allow for early identification of errors and resolution of discrepancies that can save time and resources—both financial and human resources—from being wasted. Implementation of this methodology can help to reduce increasing R&D project costs over time, including inflation-related costs, and make sure that new weapons systems are in the hands of warfighters in a timely manner amid escalating geopolitical tensions.

Second, frequent communication and direct inputs from the stakeholders in this customer-focused innovation methodology allow R&D project leaders to accurately identify and understand the needs of the client.[xxv] Furthermore, it holds the project leaders accountable and prevents workstreams from becoming siloed from evolving operational needs or maturing to a point that timely commercialization is unattainable. Early assessment of a product's theoretical viability, constant evaluation of actual viability during development and reorientation of the trajectory to meet the desired objective can help companies ensure that their investments are directed towards R&D workstreams that are most likely to reach commercialization.

By adopting the stage gate method, DoD may have more opportunities to address R&D problems as early as possible and prevent unnecessary investment in projects that are not scalable or feasible.

The graphic below demonstrates different stages of the Stage-Gate model where activities take place and five gates where decisions to either continue or end the project are made.



Source: Stage Gate International[xxvi]

A similar alternative to the Stage Gate method is the Real Options Analysis (ROA), which is a financial approach that assigns value to investment situations that are "non-financial," such as R&D that is yet to be commercialized.[xxvii] Industry players use ROA to provide opportunities, such as increasing manufacturing capacity at a factory or developing new technology, with risk-adjusted strategic values that can inform investment decision-making process. This financial modeling approach could help inform DoD's R&D selection decisions by front loading risk identification and estimating the rate of commercialization and return before making any investment.

USE OF AI AND DIGITIZATION OF DATA FOR R&D

In addition to the above project management and decision-making techniques that can guide DoD's R&D framework, there are concrete examples of how commercial industries are accelerating their R&D timetable.

Companies in the industry are also pursuing digitization of data both from and beyond clinical trials to enhance the R&D process. Specifically, investments in automation and predictive analytics help streamline drug development process with improved accuracy, and incorporation of real-world evidence (RWE) such as digital health and insurance records can help pharmaceutical companies gather more data points to increase the efficacy of new drugs under development.[xxviii]

TALENT RECRUITMENT AND DEVELOPMENT

Talent recruitment and development are also critical components of R&D that can accelerate growth in critical and emerging technologies—semiconductors, biotechnologies, artificial intelligence and machine learning—as part of the DoD's and the broader US government's long-term national security objective.[xxix] Following the nationwide prioritization to develop advanced semiconductor ecosystem in the country, many industry leading associations are investing in STEM education for students and standardizing technical curriculum for the future workforce.

For example, the Semiconductor Industry Association (SIA) is partnering with a non-profit organization focused on robotics to educate and mentor young students with a goal to develop a strong pipeline for the semiconductor industry.[xxx] By identifying and nurturing students into the niche area of semiconductors, the industry builds itself a workforce with prerequisite skills necessary for its field.

Fostering talent development can be more efficient and effective when there is a collaboration with government stakeholders. Just as how the National Semiconductor Technology Center (NSTC) is aimed to coordinate public-private partnership for semiconductor R&D, a more active role of R&D focused Defense Industrial Base Consortium (DIBC) for the DoD may be able to foster more resilient innovation in S&T and RDT&E.

Linking S&T R&D with PPBE and cost analysis

A successful S&T R&D pipeline should maintain at least one constant: supporting a *common good within resource constraints.*[xxxi] Successful R&D inherently benefits the organization and citizenry whom fund it, providing meaningful and enduring value. Portfolio Managers may rely on several specific analysis methods when developing effective and efficient R&D pipelines.

a. Feasibility and ROI analysis: Portfolio managers should develop models to verify predicted total cost through the lens of workforce planning tools, resourcing, and equipment cost. This permits determination of affordability and increases confidence in fielding estimates.
b. Impact assessments and prioritization: Portfolio managers should employ robust and validated methods for scoring and prioritization of alternatives and the impact of selective funding decisions on out-year mission capabilities.

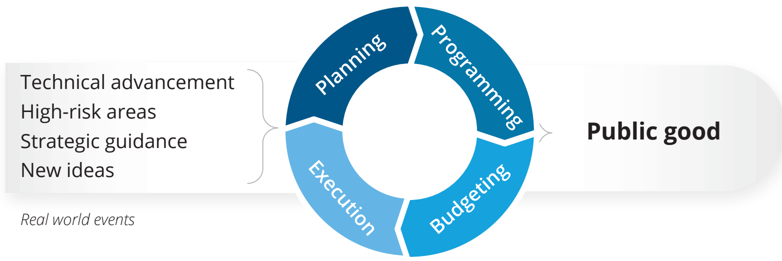
Evaluating an effective R&D pipeline through qualitative constraints such as product fit, capability, and regulatory guidelines may be the tip of the iceberg in evaluating pipeline growth, but cost/impact modeling and financial management can provide portfolio managers multiple options to obtain and objective, evidence-based viewpoint of S&T program feasibility.

The DoD PPBE process provides a framework for evaluating Courses of Action (COAs) through assignment of quantified values and predicted impact of requirements realization.[xxxii] Leading practices such as firmly-articulated requirements and benefits within the Program Objective Memorandum (POM) promote buy-in to S&T and R&D investment prioritization, and assist both stakeholders and decision-makers to view investments through the lens of this framework.

Proper emphasis on supporting resources including manpower and equipment is necessary in evaluating project effectiveness. Using forward-looking workforce planning tools and historical supporting equipment data are crucial in supplementing project information. The Office of Personnel Management's (OPM) five-step Workforce Planning model[xxxiii] evaluates specific project requirements as well as training requirements, gap reduction strategies, and strategies for identifying potential barriers. The financial cost of resourcing should also be evaluated to avoid underutilization/overutilization of resources. Historical equipment costs for similar projects can be used with an inflation factor to estimate future costs.

Portfolio managers striving to deliver on the public and organizational good objective may encounter difficulty evaluating the pipeline for R&D projects based on traditional corporate finance metrics such as future cash flow potential, return on assets, and discounted cash flow. Current gaps between project potential and ultimate outputs most often relate to project buy-in, commitment to delivery, and funding gaps. Scoring techniques used in the PPBE process mixed with key topic areas for evaluating project effectiveness may bridge this gap.

The PPBE Reform Commission has outlined the need for consistent and equitable treatment of DoD RDT&E appropriations to "protect…early-stage investments but also highlight technologies in need of continued coordination efforts between labs and users to ensure early-stage research responds to operational needs."[xxxiv] Portfolio managers can achieve consistency and equity



of evaluation as prescribed by the Commission by applying validated data and evidence-based inputs to an objective scoring regime that includes a wide selection of stakeholders and subject matter experts to inform the process. A framework of this type may include some or all of the following parameters:

- **Assessment for innovation and uniqueness.** Assessing the level of innovation and uniqueness to identify truly cutting-edge technologies with a clear potential to deliver a competitive advantage in national security.
- **Market potential.** Consideration should be given to the size and growth potential of the market for a technology. Thorough analysis to determine scalability and commercial viability of the product or solution beyond its immediate application to national security is essential, as commercial adoption enhances viability for economic feasibility and long-term sustainment.
- **Financial due diligence and revenue model.** If adopting or modifying a nascent commercial technology that is on the critical path of an S&T/R&D pipeline, an examination of the technology-owning vendor's revenue model is necessary to understand how that vendor generates income and whether the product, and possibly the vendor, are sustainable. Evaluating financial health of that company would ideally include reviewing financial statements, cash flow, profitability, and other metrics.
- **Leadership and expertise on the management team.** Evaluation of the capabilities and experience of the management team at a scientific research laboratory, national lab, University Affiliated Research Center (UARC), or Federally-funded R&D Center (FFRDC) is an often-overlooked element when making S&T investments. The team's ability to execute the business plan and navigate challenges is a critical factor in the investment decision.
- **Intellectual property (IP) and patents.** Typically in S&T projects, all IP is owned by the government; even though IP rights are increasingly being shared to encourage commercialization of novel technologies. According to Stevenson-Wydler Act, Federal Laboratories are permitted to issue exclusive license for patents.[xxxv] The number of patents or citations, however, is not directly (if at all) indicative of the value of S&T output for end-user warfighting capabilities such as survivability, lethality, and sustainability.

Example framework:

CRITERIA	PARTICIPANT #1	PARTICIPANT #2	...	PARTICIPANT #X
MANPOWER	→ 5	↑ 8		→ 5
EQUIPMENT	↓ 1	↑ 8		↓ 3
INNOVATION AND UNIQUENESS	↑ 9	→ 4		→ 5
MARKET POTENTIAL	↓ 1	↓ [illegible]		↑ 8
FINANCIAL DD/REVENUE MODEL	→ 4	↑ 8		→ 4
LEADERSHIP AND EXPERTISE	↓ 1	↓ 0		→ 3
IP/PATENTS	→ 6	↑ 10		↓ 1

EXAMPLE SCORING DATA

Note: Criteria may be assigned weightage by performance indicators by priority.

Greater insight may be gained by performing an assessment survey across S&T investments since the start of the Global War on Terror in 2001, and the systems, Programs of Record, and fielding success that followed. This historical review would capture investments with a returned value beyond the typical POM cycle, for which standard DoD KPIs and metrics are not readily applicable.

Additional outputs of a successful S&T may be considered, including the impact on policies, on-the-job training of junior researchers and scientists, and recruitment for the future workforce, all of which are difficult to capture through traditional financial metrics.

Perhaps, a binary metric of scientific success would be an effective method: Was a conclusion reached? Did the research add to the body of knowledge, and did it expand the possibilities for future work? Did it confirm that a certain line of research should not be pursued further, at least until certain other problems or obstacles upon which the research is dependent are solved? A research effort that does not push technology forward is not necessarily a failure, particularly when seeking truly pivotal, breakthrough technology advancements.

Success, therefore, may also be more appropriately measured at the portfolio level, rather project/program level, which leads to the necessary step of setting a threshold for how transformational a selected line of research must be to deserve investment, and how much.

This would also permit planners to evaluate *integration across that portfolio* as a key performance indicator (KPI). Specifically, looking across a portfolio of S&T investments, would their internal scientific activities and outputs (if some or all were successfully transitioned into R&D) support each other technologically; or are they disparate, indicating that the research organization has potentially become too diversified or strayed from their core competencies.

The critical role of data management in DoD's RDT&E success

The final dimension we explore within the RDT&E pipeline is data and data management. In R&D, the imperative for robust data management and analytics cannot be overstated. These elements are not merely auxiliary; they are the bedrock upon which informed decision-making, rapid innovation, and the seamless transition of technologies from conceptual frameworks to operational dominance are built. The complexity of modern military operations and the relentless pace of technological advancements necessitate a data-centric approach, wherein the efficacy of S&T initiatives is significantly amplified through strategic data management and analytical processes.

The DoD and associated organizations face significant challenges in the realm of data management and analytics for R&D. These challenges notably include siloed datasets, inconsistent data standards, and the underutilization of data assets. These issues not only impede the pace of technological innovation but also hinder the effective transition and scaling of new technologies that are crucial for maintaining the US technological edge in national security.

Despite the wealth of data at the DoD's disposal, there's a pervasive issue of underutilization. This underutilization stems from a combination of factors, including the lack of comprehensive data management strategies, inadequate data literacy among staff, and technological limitations in data analytics tools. Consequently, valuable insights that could potentially drive innovation and improve operational efficiencies remain untapped, significantly impacting the DoD's ability to respond swiftly and effectively to emerging threats and opportunities.

The challenges associated with data management practices directly impact the efficiency and effectiveness of S&T/R&D projects. Siloed datasets and inconsistent standards not only slow down the R&D process but also contribute to the so-called "valley of death" for many promising technologies. This phenomenon, where technologies fail to transition from research to operational use, is exacerbated by the underutilization of data, as potential applications and improvements for these technologies often go unrecognized.

In response to these challenges, it's imperative to adopt broad data management and analytics strategies. Such strategies should aim to break down data silos, standardize data management practices across the DoD, and leverage advanced data analytics tools to fully utilize available data assets. By addressing these challenges head-on, the DoD can enhance the transition rate S&T research and development into scalable programs, thereby bolstering US national security in an increasingly competitive global landscape.

To facilitate this integration, adopting frameworks and methodologies that promote data decentralization, federated governance, and treating data as a strategic asset is crucial. These principles, inspired by leading practices in data management architectures, such as the concepts like the Unified Data Reference Architecture (UDRA), provide a comprehensive blueprint for embedding data-driven insights throughout the technology development lifecycle.[xxxvi]

Data decentralization within S&T entails distributing data management responsibilities, so data is managed by those with the closest operational insights. This can enhance the relevance, quality, and accessibility of data, empowering project teams with the autonomy to manage their data efficiently. This autonomy fosters an environment conducive to rapid innovation, where data-driven insights can be integrated into the development process, from conceptualization to fielding.

Federated governance supports this decentralized approach by instituting a unified set of data management policies, standards, and protocols across S&T and its partners. This aims to create an environment where data management practices may vary across teams and projects but all adhere to a common framework that facilitates data interoperability, security, and quality. Such governance structures enable effective data sharing and collaboration, not just within the DoD but also with academia and industry partners, creating a synergistic ecosystem where collaborative innovation thrives.

Action plan

Based on our experience, to increase the S&T and overall RDT&E conversion rate, S&T practitioners need to mitigate risk, apply governance best practices, conduct comprehensive technology assessments/ analysis, align to requirements, and incorporate standard data management structures.

What undergirds these approaches is developing training to standardize the skills for S&T project lead and technology sponsors. Providing the RDT&E workforce with the requisite training to get the right technologies adopted as programs of record can ultimately help the US achieve its national security objectives and compete with near peers.

The following are common business issues across the RDT&E process that are candidates for optimization to increase the US ability to field novel—and specifically the right technologies—required on the modern battlefield.

Step 1: Apply governance leading practices.

In the realm of Technology Transition governance, an effective framework is predicated upon three essential steps that collectively facilitate a structured, accountable approach to transitioning technologies.

1. Drafting a foundational Technology Transition Agreement (TTA) that establishes the initial governance framework and sets the stage for all subsequent activities. This would include the customization of the TTA, tailored to the unique characteristics of the technology, its developmental trajectory, and the attributes of the providing entity, so governance considerations are woven into the fabric of the transition process.
2. Planning to facilitate the technology's seamless integration from S&T or R&D into its subsequent operational phase, a process governed by strategic oversight to achieve a successful "design-in." This includes the introduction of a broad governance model, embedding structured processes and oversight mechanisms to guide the entire transition period to confirm that each phase adheres to established governance protocols.
3. Rigorous evaluation process, employing specific criteria endorsed by the DoD to assess the technology's readiness and suitability for integration into the lifecycle, a testament to the critical role of governance in achieving technological excellence and operational readiness.

Central to this process is the strategic coordination of planning and estimation within the PPBE/POM framework, an exercise steeped in governance principles to achieve alignment with overarching strategic goals and fiscal discipline.

Step 2: Integrate trade-off analysis, cost modeling, impact modeling, and defining key metrics for success early in the S&T process.

Key objectives for any S&T project are to gain knowledge, make decisions on the technology based on the knowledge gained from research, and transition the right technologies into programs of record. To achieve better S&T outcomes, the S7T community should consider integrating technologies, or portfolios of technology, earlier in the POM cycle to help drive requirements and alignment to eventual program sponsors. This requires developing measure of success and instituting criteria that support sponsor outcomes early in the S&T process.

By leveraging management science techniques and aligning to the POM process, S&T professionals can be better positioned to assess, prioritize, and transition the right technologies effectively. S&T professionals can then determine, in a standardized methodology, which technologies and outcomes are well-suited to enhance their portfolio.

Step 3: Develop data management leading practices starting with data governance and common infrastructure.

Deloitte's data management and analytics services cater to the needs of the DoD, federal, and state governments with a focus on scalability and precision. Our approach leverages a scalable platform for data integration, grounded in UDRA, to help organizations address complex data challenges efficiently. We provide a unified governance solution that enables you to manage across diverse data landscapes, alongside analytics and AI services built on scalable infrastructure for in-depth data processing and analysis. Deloitte's secure data sharing framework also features advanced access controls, facilitating strategic decision-making and innovation in national security with an emphasis on operational efficiency and data-driven insights.

Operationalizing these principles requires a detailed understanding of the roles and services that support data management, so data-driven insights inform every stage of the technology development process. By prioritizing a data-centric approach, S&T professionals can overcome the identified challenges, enhancing their ability to rapidly develop and deploy innovative technologies. This strategic emphasis on data not only accelerates technological advancement, but also strengthens the DoD's ability to maintain its technological edge in an effort to remain well-positioned to address the evolving challenges of national security in an increasingly digital and data-driven era.

FINAL THOUGHTS

A recent S&T portfolio initiative has been making news across the defense industry and government. The program known as Replicator has been established to field and deliver thousands of multi-domain autonomous systems by August 2025 to hedge against influence and military buildup in INDOPACOM.[xxxvii] This initiative's core focus is to get innovative and critical technologies in the hands of the warfighter faster, at scale, and responsibly. They intend to do so through a repeatable and standard process.

Now more than ever, the ability to align requirements early in the POM cycle, establish sound governance and accountability, leverage management science techniques to evaluate technologies and get the right technologies to programs of record, and establish a unified data management structure is critical to the success of innovative initiatives.

Deloitte services

a. Economic modeling and valuation

Deloitte's specialists build economic models that can help the US government assess the financial implications of existing and potential drivers and to formulate tailored optimization strategies. Deloitte's economic specialists conduct modeling, scenario-based analysis, and simulation exercises. These services help clients understand the implications of industry trends for the US government and assess potential risks as well as develop possible options to mitigate and potentially eliminate those risks.

b. Planning, Programming, Budgeting, and Execution (PPBE)

Deloitte's clients encompass DoD's PPBE process across several verticals, and our service offerings span many components of the budgeting cycle. Our professionals have subject matter experience throughout the PPBE process and are very familiar with cost tracking and workforce planning methodologies. Additionally, Deloitte's Government and Public Services clients include those with dated budget model tools, and our professionals can provide software implementation and process improvement COAs across industry and government.

c. Quantitative risk and decision analysis

Deloitte's clients include DoD services, federal, and state governments. Our professionals range from DoD specialists with 40+ years of specialized DoD major defense acquisition experience to financial economists and data science analysts. Deloitte's specialists may also apply the methodology to planning, PPBE; S&T; and R&D transition. The analysis would include a forecast of the inflation factors, cost estimates, and would provide mitigation recommendations for large investment in DoD R&D.

d. Supply chain and industrial base

Deloitte's specialists are equipped with state-of-the-art tools like CentralSight™ which can illuminate and separate components of the supply chain from tier 1 prime contractors through tier 2-x. When the supply chain illumination data analysis and visualization tools are combined with Deloitte's business analysis of individual companies, valuable insights are generated that can drive decision making within the government.

f. Commercial aerospace and defense leader

Deloitte is a leading presence in the A&D industry, providing services to greater than 95 percent of the Fortune 500 A&D companies through more than 1,500 practitioners. Many of our practitioners have worked in the A&D industry and/or the military prior to joining our organization and have deep industry experience across many sectors. The level of experience and connectivity of these practitioners allows us to provide insights and observations regarding the latest in commercial concepts, technology, and operating procedures to help our clients address their most pressing issues.

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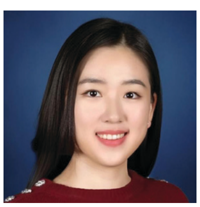

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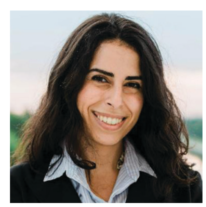

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