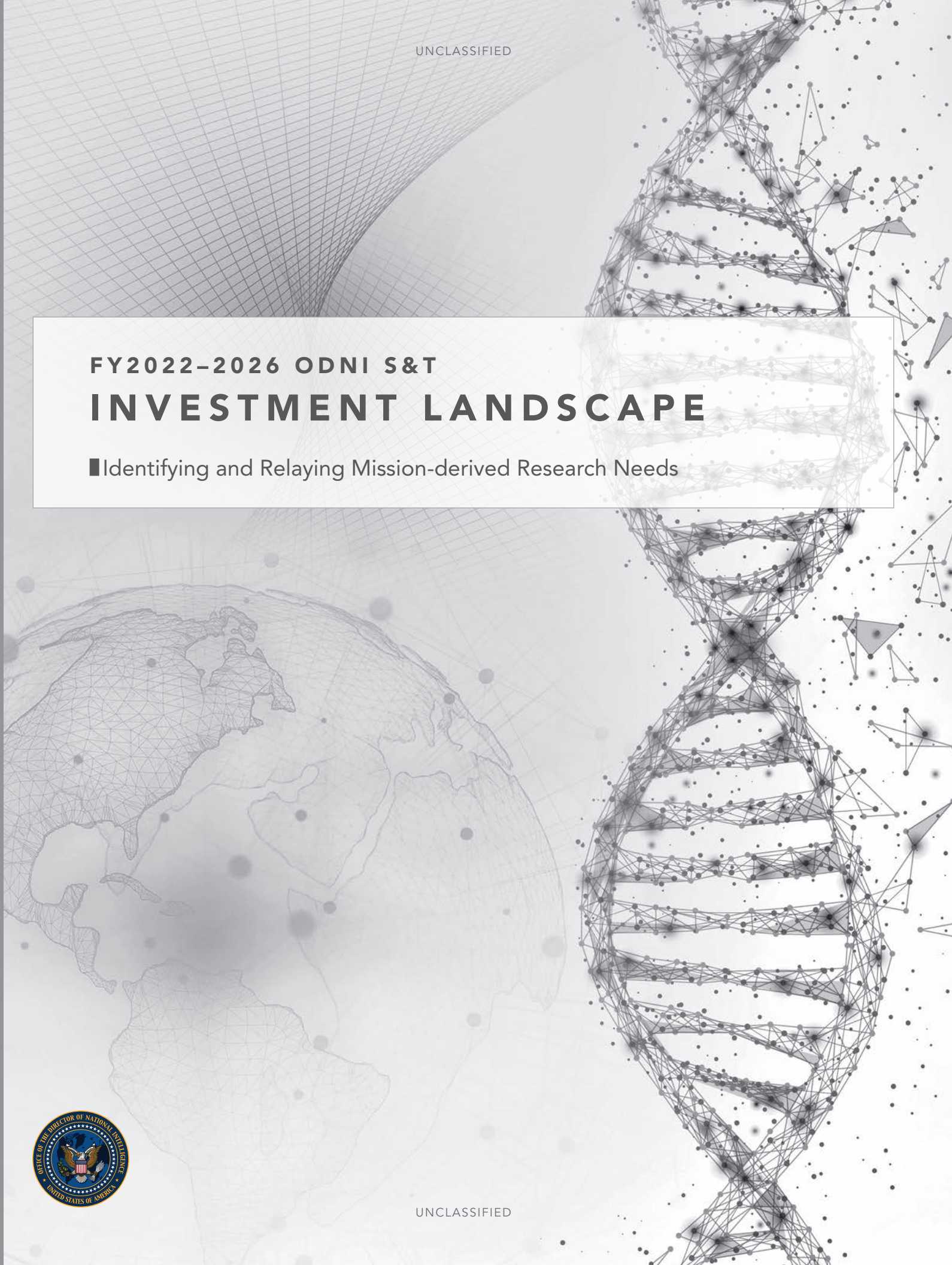


FY2022–2026 ODNI S&T

INVESTMENT LANDSCAPE

Identifying and Relaying Mission-derived Research Needs

FY2022–2026 ODNI S&T
INVESTMENT LANDSCAPE

Identifying and Relaying Mission-derived Research Needs

About the Cover

The cover graphic portrays the convergence of disparate science and technology disciplines as central to the intelligence profession. Stretching vertically down the image, a double helix strand of deoxyribonucleic acid (DNA) appears as a futuristic rendering surrounded by fragments of information, suggesting the prospect of breakthrough at the confluence of biology and data analytics. This illustration represents but a single example of the Intelligence Community's wide-ranging interest in possible scientific and technological convergence, from which innovation and disruption often arise. In the near term, perhaps no technology will have greater influence on accelerating such innovation and disruption than artificial intelligence, which is represented in the graphic by grid patterns converging into a single, luminous, curved line. The silhouette of Earth conveys the international scope of the intelligence enterprise, the global nature of scientific knowledge and technological advancement, and the capacity to carry out worldwide operations as interlinked and integrated pillars of mission success.

FROM THE DIRECTOR OF NATIONAL INTELLIGENCE AND THE PRINCIPAL DEPUTY DIRECTOR OF NATIONAL INTELLIGENCE:

As President Biden noted in the White House's *Interim National Security Strategic Guidance*, our nation will only succeed in advancing our interests and upholding our universal values by working in common cause with our closest allies and global partners in industry and academia, and by renewing our own enduring sources of strength. Although the Intelligence Community's (IC) technological edge has long been one of these sources of strength, maintaining and increasing this advantage require us to look beyond the immediate horizon to ensure that we are postured to address developing threats and take on new opportunities as they arise.

The Office of the Director of National Intelligence's (ODNI) Science and Technology (S&T) Investment Planning Guidance—composed of the *FY2022–2026 ODNI S&T Investment Landscape*, the *FY2022–FY2026 ODNI S&T Strategic Plan*, and the *FY2022–2026 ODNI S&T Strategic Investment Framework*—collectively lays the foundation for better positioning the IC to advance our nation's interests by anticipating and preparing for the demands of the future. These documents serve as a roadmap for advancing and sustaining a diverse and talented technical workforce, championing and advocating for S&T that is not only effective but will provide the IC with a competitive advantage, enhancing and creating enduring and purposeful partnerships with a range of non-traditional public and private partners, managing risk, and integrating expertise across a range of technical and mission-oriented disciplines. Additionally, these documents clarify how we will work together within the IC and alongside our partners to identify, champion, and catalyze investments to ensure our continued technological advantage through a whole-of-nation approach to innovation.

Despite its unparalleled strengths, the IC cannot address these challenges alone. We look forward to the Community and its partners using these documents as a common basis for advancing our nation's intelligence advantage.

The Honorable Avril D. Haines
Director of National Intelligence

The Honorable Stacey A. Dixon
Principal Deputy Director of National Intelligence

From the Deputy Director of National Intelligence for Policy and Capabilities:
To best posture the U.S. Intelligence Community (IC) to meet future challenges, today's decision makers must anticipate over-the-horizon threats to our national security and marshal an integrated, collaborative, and systematic approach to driving Community investment in science and technology (S&T). As the foundation for these efforts, the *FY2022–2026 ODNI S&T Investment Landscape* identifies and projects the IC's S&T Needs for preserving and advancing our intelligence advantage. Along with its companion documents, the *FY2022–2026 ODNI S&T Strategic Plan* and *FY2022–2026 ODNI S&T Strategic Investment Framework*, the *Landscape* plays a critical role in sharing key information with industry partners, researchers, and other technology developers whose expertise and agility will significantly augment the IC's ability to continuously field cutting-edge capabilities in the present and coming era of rapid and disruptive technological change.

Mr. Dustin J. Gard-Weiss
Deputy Director of National Intelligence for Policy and Capabilities
Office of the Director of National Intelligence

From the Director of Science and Technology:
Awareness of mission-related challenges is key to renewing and ensuring our nation's intelligence advantage, and this *Landscape* is one way the IC can engage with a range of stakeholders on our anticipated problems to create the Community of the future. The *Landscape* documents IC challenges and relays them to prospective solvers, and has been a proven mechanism for positioning the IC to address future challenges. My office and I are committed to help posture the IC, through forceful advocacy on behalf of the Community, to address future challenges with adaptability and resilience. Your feedback is most welcome, and can be provided to S&TInvestment@dni.gov. ODNI's Science and Technology Group looks forward to hearing from you.

Dr. John R. Beieler
Director of Science and Technology
Office of the Director of National Intelligence

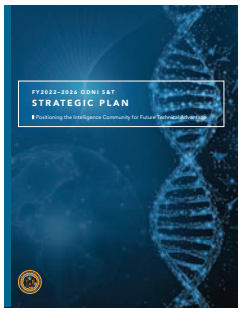
From the Deputy Director of Science and Technology:
This *Landscape* builds on the successes of ODNI's *FY2015–2019 IC S&T Landscape*, which served to identify and champion IC-wide needs and provided an opportunity for IC leaders and stakeholders, such as the National Intelligence Managers, to directly affect the allocation of IC and industry R&D resources. In this way, the publication of this revised *Landscape* represents ODNI's renewed commitment to relay our captured challenges to a variety of partners—to include those in cleared industry, broader commercial entities, academia, and the larger U.S. Government—and work collaboratively to ensure U.S. advantage in the future intelligence environment.

Dr. David M. Isaacson
Deputy Director of Science and Technology
Office of the Director of National Intelligence

ODNI SCIENCE AND TECHNOLOGY GROUP PUBLICATIONS

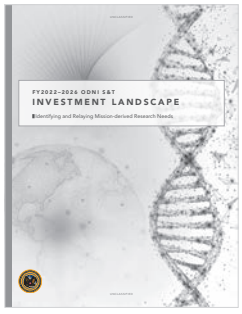
The below documents collectively capture and relay how the Office of the Director of National Intelligence (ODNI) Science and Technology Group (STG) substantively develops—in a transparent, repeatable, and inclusive fashion—its statutory requirement for investment recommendations to the Director of National Intelligence (DNI).

These documents broadly outline STG's roles and activities to a range of internal (ODNI) and external (IC, U.S. Government, private sector) stakeholders.



FY2022–2026 ODNI S&T Strategic Plan

This *Plan* identifies the guiding principles for IC S&T Enterprise Investment and articulates four key goals for the ODNI intended to set the landscape for the development of S&T throughout the IC to ensure our technical advantage and more effectively pursue the IC's mission.



FY2022–2026 ODNI S&T Investment Landscape

This report identifies the principal challenges facing the national security enterprise in order to focus S&T investment efforts on the IC's critical needs. It describes the process by which the STG generates recommendations to the DNI and the broader IC on the capabilities, associated technologies and research areas that will address the future needs of the community. This *Landscape* additionally serves as the basis for ODNI's longer-term investment strategy.

FY2022–2026 ODNI S&T Strategic Investment Framework

This publication explains how the STG will identify and manage risk within the IC's research portfolio, given that it is not fiscally or otherwise possible for the IC to anticipate and sufficiently address every potential challenge. The approach outlined in this *Framework* is intended to ensure that in managing risk, the needs of users and customers are closely coupled to decision-making informed by technology subject matter experts.

CONTENTS

Chapter 1
Introduction and Motivation

THE NEED FOR A RATIONAL, TRACEABLE, AND DEFENSIBLE BASIS FOR ENGAGEMENT

The threat environment facing the U.S. national security enterprise is dynamic, and the Intelligence Community (IC) can ill-afford to remain static. Accordingly, flexibility and adaptability are key to maintaining decisive and enduring intelligence advantage for our nation and its allies. Given this reality, the Community must develop approaches and partnerships for actively signaling to the public and private sectors alike those research challenges that the IC anticipates facing. As the basis for meaningful engagement with a broad range of stakeholders, the IC S&T enterprise must clearly articulate its principal challenges and provide a variety of means for prospective solvers to market their capabilities.

Developed by the Office of the Director of National Intelligence (ODNI) Director of Science and Technology (DS&T), the *FY2022–2026 ODNI S&T Investment Landscape* is designed to increase the level of transparency into documented challenges facing the national security enterprise and to better align public- and private-sector efforts in support of these intelligence Needs. Relaying intelligence challenges at the Top Secret, Secret, and Unclassified levels, the *Landscape* provides not only the intelligence enterprise, but also the broader national security enterprise and basic research community with additional insight and clarity into challenges the Community is likely to encounter in the coming years.

The *Landscape* is meant to lay the foundation for generating meaningful, clearly articulated thrusts in areas critical for aligning IC S&T enterprise and partners' pursuits with future intelligence and broader national security Needs. In this way, the *Landscape* will no doubt help better position the IC S&T enterprise to play its part in achieving the goals articulated in ODNI's guidance and planning processes, as shown in Figure 1.1.

Transparency, collaboration, and inclusiveness are central tenets of the *Landscape*. A critical component of ODNI's DS&T-led Science and Technology Group (STG) and its predecessor groups in recent years remains their relationship with industry to develop technical roadmaps for addressing IC mission Needs. Initial mission areas addressed through these activities include enduring challenges such as cybersecurity, novel sensor development, space capability resilience, data management, advanced analytics, and counter-proliferation. As their content spans across mission capabilities to supporting technologies to research challenges, these roadmaps have already proven useful to a wide range of audiences across the public and private sectors, to include program offices, system engineers, and scientists.

Figure 1.1 — **The *Landscape's* Relation to Broader ODNI Investment Planning**

The ODNI is committed to providing clear, consistent, and actionable direction to the IC to develop agency budgets, specifically through the Intelligence Planning, Programming, Budgeting, and Evaluation (IPPBE) process. The *Landscape* is used to directly contribute to ODNI's STG-led S&T Investment Planning Guidance as well as to inform S&T investments and provide direction in the broader IPPBE process. The documents below convey ODNI's and the IC's strategic vision clearly and consistently throughout each phase of the IPPBE process.

National Intelligence Strategy (NIS): The NIS is published every four years and provides a strategic framework for the IC's annual IPPBE cycle. It offers strategic direction to the IC through the mission and enterprise objectives. In addition to the NIS, other national-level strategies provide strategic direction to IC elements within larger Departments and inform the IC on their Department's intelligence support needs.

Intelligence Planning Guidance (IPG): Using the strategic direction from national strategies, the biannual IPG incorporates assessments of mission and enterprise health to prioritize areas and cross-cutting enabling capabilities. It establishes the priorities and risk areas under which IC elements should align their program-specific priorities when developing their annual budget submission to the National Intelligence Program (NIP). In particular, the IPG identifies mission and enterprise areas where IC elements can accept additional risk based on requirements and mission resiliency. The IPG's priorities, risks, and cross-cutting capability needs are the foundation for programming guidance.

Consolidated Intelligence Guidance (CIG): The CIG translates the mission and enterprise priorities from the IPG into Strategic Outcomes and Programmatic Actions. Strategic Outcomes establish the expected end-states for achieving prioritized mission and enterprise objectives. Programmatic Actions identify the most important efforts necessary to fill current and future capability gaps leading to those end-states. In many cases, community-wide solutions will be required. Program Managers then adjust their NIP and Military Intelligence Program resources in innovative ways to reach these end-states and implement specific Programmatic Actions.

Fiscal and Procedural Guidance (FPG): The ODNI fiscal guidance outlines the IC's coordinated level of investment in the NIP and implementing instructions to support the President's priorities, management agenda, and budget. The annual IC fiscal guidance provides funding guidance for programs to use in budget development and establishes the topline funding priorities for each program to support the President's budget, while procedural guidance specifies how programs will document their budget requests to justify the requested investments.

Chapter 2
ODNI's Methodology for Identifying, Categorizing, and Assigning IC-wide S&T Needs

The overarching objective of the *Landscape* Needs is to provide the foundation for generating—in an efficient and collaborative fashion—substantiated investment recommendations to the Director of National Intelligence and the broader IC on the capabilities and associated technologies and research areas that will address the future needs of the Community. The original iteration of this list—identified within the full TS|SCI version of the *FY2015–2019 IC S&T Investment Landscape*—was designed to shape IC S&T and industry independent research and development (IRAD) investments through FY2019 and beyond, and provided a set of precepts to guide decisions about the size and shape over subsequent program and budget cycles.

- The *Landscape* document served to champion IC-wide Needs which did not map directly to individual IC elements' functional responsibilities, and was also meant to provide an opportunity for IC leaders and stakeholders, such as the various National Intelligence Managers (NIM), to directly affect the allocation of IC S&T and industry IRAD resources.

The overarching objective of the Landscape *Needs is to provide the foundation for generating—in an efficient and collaborative fashion—substantiated investment recommendations to the Director of National Intelligence and the broader IC on the capabilities and associated technologies and research areas that will address the future needs of the Community.*

IDENTIFYING IC-WIDE S&T NEEDS

Much has changed around the globe since the original *Landscape* was released. To that end, the *Landscape's* updated Needs list represents the IC's first revised attempt to link the needs of integrated intelligence to the S&T tradespace of the future, and in doing so offers a means to efficiently allocate today's scarce R&D resources in anticipation of future IC needs.

Like the original Needs, a critical part of developing the latest *Landscape's* Needs was to review and update the previously captured mission challenges while identifying and incorporating additional Needs from across the IC. To accomplish this objective in a manner calculated to reasonably catalogue all intelligence needs of the Community, STG staff sought to identify and revalidate intelligence needs from a variety of disparate sources with differing perspectives: subject matter experts, program managers, specialized customers, and field end-users. Source documents and other inputs included the NIMs' Unifying Intelligence Strategies (UIS); the Department of Defense (DoD) Unified Combatant Commands' (UCC) Integrated Priority Lists (IPL); inputs from the Department of State's Bureau of Arms Control, Verification, and Compliance (AVC) Verification Technology Research and Development needs; a number of IC elements' S&T strategies; and inputs from various Specialized Mission Managers, including law enforcement and homeland security.

- A key objective of this updated list is the refinement of the Needs set to reduce duplication while providing additional details on the nature of the Needs.

What Does the Landscape *Needs List Not Do?*

As with the FY2015–2019 IC S&T Investment Landscape, *the* FY2022–2026 ODNI S&T Investment Landscape *Needs are designed to provide a reasonably comprehensive look at how problem "owners" across the Community see the challenges within their area(s) of responsibility. As such, it does not seek to be prescriptive in the technologies required to address these documented Needs, nor does it explore specific, future technical approaches for addressing the IC's current and projected Needs. In this way, it is intended to provide an open dialogue between problem "owners" and prospective "solvers," the latter of which may have ideas that fundamentally transform the nature of the original Need to be addressed.*

CATEGORIZING AND ASSIGNING IC-WIDE S&T NEEDS BY MISSION PROGRAM

A critical change in this iteration of the *Landscape* was the assignment of captured Needs to IC Program Managers (PM). STG pursued this approach primarily to better align its efforts to capture mission-related challenges with its efforts to understand the IC S&T enterprise's research portfolio, which is generally aligned to a specific IC program.

Once IC-wide needs were appropriately aggregated, they were then filtered into various categories based largely on which IC Program Manager(s) or other entities would be best positioned to bring to fruition a solution to a given IC Need, as shown below in Table 2.1.

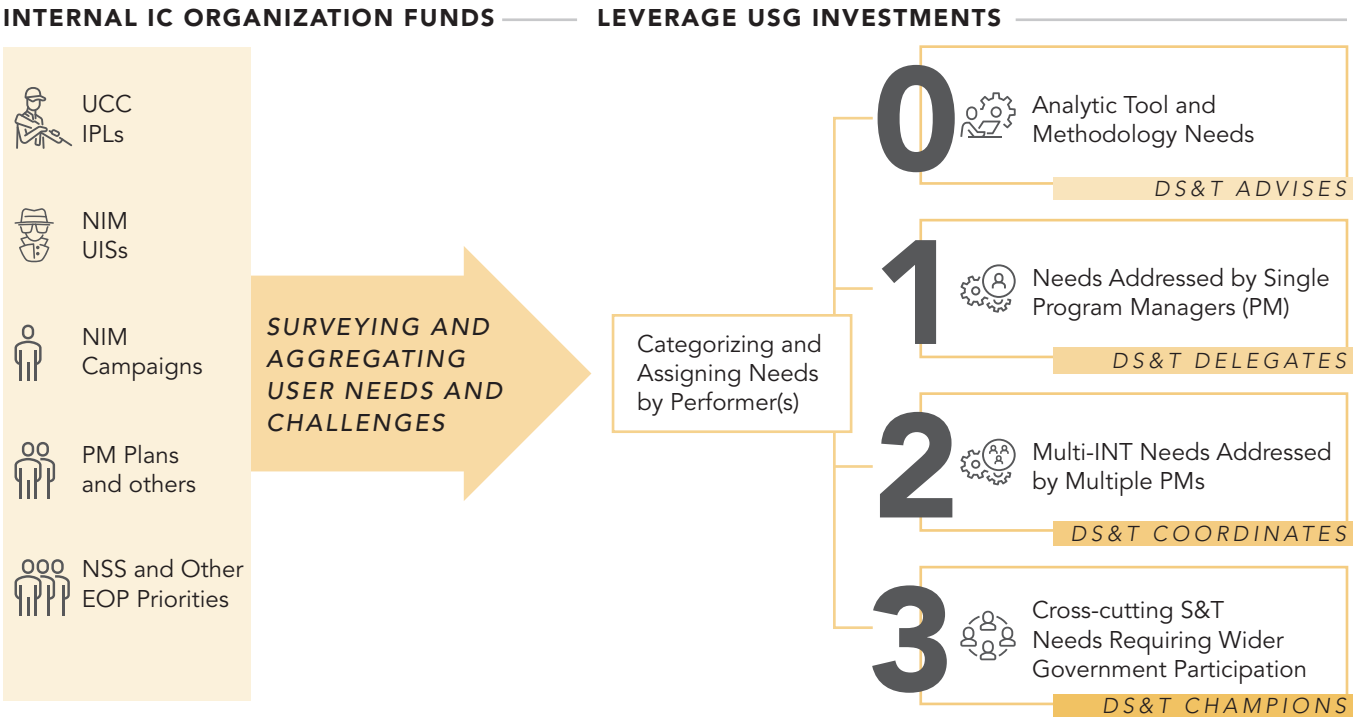
Table 2.1 — **Mission Program–Derived Categorization of *Landscape* Needs**

NAME	BRIEF DESCRIPTION	EXAMPLE NEEDS
Category Zero	IC-wide analytic tool and methodology challenges.	Develop/enhance capabilities to mitigate bias introduced by machine learning techniques.
Category One	IC-wide S&T challenges that are best served by an individual Program Manager.	Develop/enhance understanding of global dual-use technologies that may be used for chemical, biological, radiological, and nuclear weapons programs.
Category Two	IC-wide S&T challenges that are potentially served by more than one Program Manager.	Develop/enhance analytic tools to identify critical and non-traditional indicators of nation-state instability, and/or threats to U.S. or Allied personnel and interests in a region.
Category Three	IC-wide S&T challenges that are best served by leveraging external and/or broader U.S. Government partners.	Develop/enhance standards and methods to address challenges of processing, sharing, and analyzing spectral and spatiotemporal data within emerging high-performance computing and cloud architectures.

This methodology of basing decisions on mission programs was selected to avoid the "binning" that often occurs when Needs are subdivided into various topical areas. The process of collecting and filtering these Needs is shown schematically in Figure 2.1.

Figure 2.1 — **Selection Process for Assigning Needs to Various Performers**

Note that from Category Zero to Category Three Needs, the role of the DS&T increases commensurately, moving from advising to ultimately championing S&T-related activities within the IC.



Why Categorize by Program Managers Instead of Functional Managers?

The proper assignment of Needs to those with clearly-defined intelligence mission alignment is critical to solving the Needs of the FY2022–2026 ODNI S&T Investment Landscape. *The previous version of the* Landscape *assigned Needs to National Intelligence Program (NIP) Functional Managers (FM) based upon the Needs' alignment to particular intelligence mission lines (GEOINT, HUMINT, SIGINT, etc.). For this iteration of the* Landscape, *STG chose to align the Needs to Program Managers (PM), whose roles are primarily resource oriented—i.e., defined by budgets and personnel.*

CATEGORIZING AND ASSIGNING IC-WIDE S&T NEEDS BY TECHNOLOGY DOMAINS

In addition to assigning the aggregated Needs to their respective PMs, the Needs were also sub-categorized based on their technology domain(s), as determined by STG analysts, which were further broken down into various tiers to provide increasing levels of detail. The various technical domains used for categorizing the *Landscape* Needs are presented in Table 2.2.

Table 2.2 — **Technology Domain–Derived Categorization of *Landscape* Needs**

TIER 1 TECH DOMAINS	TIER 2 TECH DOMAINS	DESCRIPTION
Artificial Intelligence	Adversary Models Autonomous Systems Deep Learning Human Language Technology Human–Machine Teaming Information Assurance Machine Learning Pattern Recognition Recommender Systems Summarization Engines	Sometimes called machine intelligence, artificial intelligence (AI) is the branch of computer science focused on programming machines to perform tasks that replicate or augment aspects of human cognition, such as learning, seeing (computer vision), understanding, and problem solving.
Behavioral Sciences	Cognition Crowdsourcing Deception (Research) Neuroscience Psychology	The behavioral sciences denote the set of disciplines that focus on the behavior, attitudes, beliefs, and practices of people and their organizations, communities, and institutions, and include two broad categories: neural (information sciences) and social (relational sciences).
Biological Sciences	Bioeconomy Collection and Detection (e.g., Signatures) Computer and Information Services Cyber Biosecurity DNA Data Storage Emerging Biotechnology Genomic Manipulation/Alteration Synthetic and Metabolic Engineering Tests, Kits, and Services	The biological sciences focus on the study of life and living organisms. They specifically include the life, biomedical, bioindustrial, environmental, agricultural and related sciences in addition to associated enabling technical applications (biotechnology).
Chemical Sciences	Collection and Detection (e.g., Signatures) Emerging Technology Energetics Sensors Tests, Kits, and Services	The chemical sciences entail the study of elements and compounds composed of atoms, molecules, and ions; their composition, structure, properties, and behavior; and the changes they undergo during a reaction with other substances.

Table 2.2 — **Technology Domain–Derived Categorization of *Landscape* Needs**

TIER 1 TECH DOMAINS	TIER 2 TECH DOMAINS	DESCRIPTION
Communications	Geolocation Infrastructure Satellite Telecommunications Telemetry Underwater	Communications is the exchange of information between two or more parties, entities, and/or organizations, and includes associated technologies and/or methods used to enable the transfer of information.
Computing	Augmented/Virtual Reality Biologically Inspired Cloud High Performance Computing Modeling and Prediction Algorithms Photonic Quantum	Computing is the use of machines to manage, process, and communicate information, and includes the design and development of both software and hardware systems.
Cyber	Blockchain Cryptography Cryptomathematics Defensive Internet of Things Offensive Supply Chain (Risk Management)	Relating to, involving, or characteristic of computing, computer networks, information technology, virtual systems, the Internet of Things (IoT), or computer-enabled control of physical components. Cyber also relates to the culture encompassing use of computers, information technology, and virtual reality.
Data	Audio Change Detection Computational Analytics Digital Identity Digital Media Extraction Link Analysis Modeling and Prediction Video/Image Visualization Privacy Integration Storage Metadata Graph Analytics	Data are sets of qualitative and/or quantitative information, such as alphabets, numbers, or symbols, that refer to, or represent, conditions, ideas, or objects. They may also include symbols or signals that are input, stored, and processed by a computer, for output as usable information.
Electronics	Communication Embedded Systems Electronics Integration Electronic Materials Hardened Secure Microelectronics Sensing Size, Weight, and Power (SWaP) Transmission	Electronics is the study and use of electrons, including their transport and interactions, in materials and vacuum, for applications such as information technology, signal processing, sensors, communications, secure systems and control systems.

Table 2.2 — **Technology Domain–Derived Categorization of *Landscape* Needs**

TIER 1 TECH DOMAINS	TIER 2 TECH DOMAINS	DESCRIPTION
Energy and Power	Alternative Generation Endurance Harvesting High Density Size, Weight, and Power (SWaP) Storage	Energy is the ability to exert an effort and accomplish work—such as lifting a weight in a gravitational field, separating electrical charges, or forcing a chemical reaction—and can be stored in devices such as batteries or harvested from the environment. Power is generally defined as the rate at which work is performed, or energy is transmitted or released.
Forensics	Biological Biometric Chemical Computer Data Document and Media Exploitation Materials Network Nuclear Reverse Engineering	Forensics is the application of science and technology to investigate, characterize, attribute, and link events, locations, items, signatures, nefarious intent, and persons of interest.
Identity	Attribution Biometrics Counter-Detection Manipulation Detection Pattern of Life	Identity is the distinctive, measurable characterization of individuality. Detecting and establishing identities involves unique determinants such as personality, biometrics, social and cultural markers, actions, and behaviors.
Materials and Manufacturing	Additive Manufacturing Bio-Inspired Hardening Metamaterials Micro Nano Optics Reverse Engineering Robotics Smart Manufacturing Stealth	Advanced materials and manufacturing processes serve as a foundation for a variety of applications, to include automation, computation, software, sensing, networking, and emerging capabilities in such areas as nanotechnology, chemistry, pharmaceuticals, and biology.
Nuclear Science	Characterization Collection and Detection (e.g., Signatures) Forensics Handling Processing	Nuclear science examines the nuclei of atoms and the energetics involved when these nuclei are split or combined or otherwise processed such as enriched. Enhanced understanding of these interactions may lead to new, more efficient materials, energy generation, and therapeutics.

Table 2.2 — **Technology Domain–Derived Categorization of *Landscape* Needs**

TIER 1 TECH DOMAINS	TIER 2 TECH DOMAINS	DESCRIPTION
Position, Navigation, and Timing (PNT)	Astronomy Astrophysics Geodesy Geolocation Navigation Spatial Temporal	PNT, which enables GPS and other systems, is a combination of three distinct, constituent capabilities: • Positioning – the ability to accurately and precisely determine one's location and orientation two-dimensionally (or three-dimensionally when required) referenced to a standard geodetic system (such as WGS84). • Navigation – the ability to determine current and desired position (relative or absolute) and apply corrections to course, orientation, and speed to attain a desired position anywhere around the world, from sub-surface to surface and from surface to space. • Timing – the ability to acquire and maintain accurate and precise time from a standard (UTC), anywhere in the world and within user-defined timeliness parameters.
Sensors	Acoustic/Seismic Biological Chemical Data Processing Electromagnetic Gravity Integration Multi-Phenomenology Optical Persistence Protection Quantum Radiation Survivability	A sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment. Detected input may include light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena.
Space	Access Characterization Command and Control Missiles Operations Resilience Satellites	Space starts 12 miles below the Kármán Line, at 50 miles above Earth's surface, where activities and technologies may be related to sub-orbital flight, low earth orbit (LEO), medium earth orbit (MEO), and geosynchronous orbit (GEO). Space-related capabilities may also include associated ground systems and other supporting infrastructure.

Table 2.2 — **Technology Domain–Derived Categorization of *Landscape* Needs**

TIER 1 TECH DOMAINS	TIER 2 TECH DOMAINS	DESCRIPTION
System of Systems	Acknowledged Collaborative Directed Networks Virtual	System of Systems (SoS) is a collection of task-oriented or dedicated systems that pool their resources and capabilities to create a new, more complex system which offers more functionality and performance than simply the sum of the constituent systems. SoS is the viewing of multiple, dispersed, independent systems in context as part of a larger, more complex system. A system is a group of interacting, interrelated, and interdependent components that form a complex and unified whole.
Other	Unconventional Unexpected Unwarned Novel Imaginative Convergent Opportune	S&T-related effort that cannot be meaningfully categorized within another provided Technology Domain, or any effort that inherently involves a broad range of potential S&T-related topics, to include: • An event, idea, procedure, invention, discovery, or technology that effects a significant shift in the current manner of doing or thinking about something; • A newly introduced element or factor that changes an existing situation or activity in a significant way; or • A critical technology having the potential to alter an overall outcome (generally, but not always, in a positive manner).

Using the categorization processes outlined in Tables 2.1 and 2.2, STG has endeavored to markedly increase the level of transparency into NIM- and UIS-identified, as well as broader, challenges facing the national security enterprise and thus enable better alignment of public- and private-sector efforts in support of these intelligence Needs.

Chapter 3
ODNI-captured IC S&T Investment Needs

The *Landscape* continues the IC's attempts to link the needs of integrated intelligence to the S&T tradespace of the future, and in doing so offers a means to efficiently allocate today's scarce R&D resources in anticipation of future IC needs. Accordingly, the *Landscape* advances the ODNI's leadership of the NIP and the IC. It reflects an attempt to relay many of the most pressing IC-wide needs that ensuring U.S. national security will require, and it also affirms priorities to focus IC plans and actions for the next five years, while providing direction to guide development of future IC capabilities.

IC-WIDE ANALYTIC TOOL AND METHODOLOGY NEEDS (*CATEGORY ZERO NEEDS*)

Many IC needs do not require the development of new collection or associated capabilities, but rather pertain to better understanding and/or fusing existing data. STG denotes this type of IC Need as a *Category Zero Need*.

Table 3.1 — **IC-wide Analytic Tool and Methodology Needs (*Category Zero Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N005	Develop/enhance understanding of global technology development lifecycles and transition plans.		x			x		x									x		x	
2N092	Develop/enhance agile, scalable, accessible, and reliable methods of processing disparate data.	x					x		x	x										
2N093	Develop/enhance capabilities to flag anomalies within massive data sets.	x					x		x											
2N100	Develop/enhance 3D/4D visualization capabilities to display multi-source data in spatiotemporal context.								x							x			x	
2N132	Develop/enhance capabilities to mitigate bias introduced by machine learning techniques.	x	x						x											x

Table 3.1 — **IC-wide Analytic Tool and Methodology Needs (*Category Zero Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N133	Develop/enhance capabilities to rapidly reconstruct flight trajectories of missiles and aircraft.	x					x		x			x				x	x			
2N136	Develop/enhance simulation capabilities of weapon systems in battlefield environments.	x					x		x											
2N137	Develop/enhance methods for interpolating computer-aided design representations from incomplete source data.	x					x		x											
2N139	Develop/enhance high-performance computing capabilities.						x		x	x	x			x						
2N163	Develop/enhance automated, secure, and seamless data transfer across networks of varying security levels.	x					x		x	x										
2N164	Develop/enhance capabilities to maintain data provenance while allowing for updates to new systems, processes, and procedures.						x		x	x						x				
2N166	Develop/enhance capabilities to lower the lifecycle cost of data aggregation, storage, and stewardship.						x		x	x										
2N178	Develop/enhance analytic capabilities to quickly identify deception techniques.	x					x		x								x			

IC-WIDE S&T NEEDS THAT ARE BEST SERVED BY A SINGLE PROGRAM MANAGER *(CATEGORY ONE NEEDS)*

Particularly since the passage of the Intelligence Reform and Terrorism Prevention Act of 2004 and the subsequent standup of the ODNI, there has been a concerted effort to better integrate the IC. Although this is useful for a number of purposes, such as intelligence sharing, STG's breakdown of IC-wide needs demonstrates that it also remains essential for individual PMs to maintain IC competencies in key areas. STG has denoted this type of Need as a *Category One Need* to signify that they are, in STG's judgment, best served by a single PM.

Table 3.2 — **Single Program Manager Needs (*Category One Needs*)**

NEED	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N010	Develop/enhance capabilities for creating a cybersecurity common operating picture.						x	x	x										
2N019	Develop/enhance understanding of global dual-use technologies that may be used for chemical, biological, radiological, and nuclear weapons programs.			x	x							x		x	x		x			x
2N027	Develop/enhance computational methods for analysis of geospatial information to detect anomalies.	x					x		x			x				x				
2N028	Develop/enhance computational methods related to the interdisciplinary field of human geography for discovery of complex patterns and processes.	x	x				x		x				x			x				
2N032	Develop/enhance capabilities to collect, process, and analyze information on integrated systems to develop models of complex systems of systems.	x					x		x								x		x	
2N089	Develop/enhance photogrammetric techniques to improve geospatial accuracies.						x		x							x	x		x	
2N121	Develop/enhance capabilities to detect and characterize adverse omic modifications in nonhuman species.	x		x					x			x	x							
2N159	Develop/enhance secure data and voice communication.					x		x	x				x							
2N177	Develop/enhance sensors and processing techniques that identify attempts to conceal objects.	x							x			x					x			

Lastly, it should be stressed that ODNI recognizes the deep expertise needed to pursue these Needs. Accordingly, the DS&T's role with respect to *Category One Needs* is to match Needs with those PMs that are best suited to solve these problems, entrusting the PM and the entity or entities expressing the need to work together to find a solution. Industrial partners are expected to work directly with the PM or designee.

MULTI-INT, IC-WIDE S&T NEEDS BEST ADDRESSED BY SEVERAL IC PROGRAM MANAGERS *(CATEGORY TWO NEEDS)*

The previous chapter illustrates the large number of problems that are best served by a single PM. In addition to these *Category One Needs*, STG's breakdown of Needs shows that it is essential for PMs to work together to exploit IC competencies in key areas *exclusively within the realm of the National Intelligence Program*. STG continues to denote S&T Needs that are best served by combining the resources of multiple PMs as *Category Two Needs*.

As the *Category Two Needs* are more cross-disciplinary than those of *Category One*—touching at least several elements and PMs across the NIP—the DS&T and the Director of National Intelligence Science and Technology Committee (NISTC) expect to play a stronger role in addressing these Needs, including potentially coordinating activities across participating IC elements.

Table 3.3 — **Multi-INT, IC-wide S&T Needs Best Addressed by Several IC Program Managers (*Category Two Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																		
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N002	Develop/enhance capabilities to collect information on global science and technology activities.						x	x				x					x			
2N006	Develop/enhance capabilities to advance space situational awareness.					x											x	x	x	
2N011	Develop/enhance near-real-time cyber forensics.	x					x	x	x			x								
2N013	Develop/enhance capabilities to detect and attribute malign cyber activity.	x						x	x			x					x			
2N018	Develop/enhance methods to discriminate offensive biological activities from defensive programs or other non-offensive research.	x		x	x									x			x			
2N020	Develop/enhance methods to detect, assess, and/or evaluate current and emerging threats that cause death, disease, or other biological malfunction of the neurological system.	x	x	x	x				x			x		x			x			

Table 3.3 — **Multi-INT, IC-wide S&T Needs Best Addressed by Several IC Program Managers (*Category Two Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N021	Develop/enhance analytic tools to identify critical and non-traditional indicators of nation-state instability, and/or threats to U.S. or Allied personnel and interests in a region.	x	x					x	x				x						x	x
2N026	Develop/enhance understanding of polarimetry to improve automated processing and object detection and identification.	x					x		x	x							x	x		
2N031	Develop/enhance capabilities to reconstruct and visualize adversaries' military exercises and related activities.	x	x				x		x								x			
2N034	Develop/enhance methods and capabilities to detect and characterize underground facilities, activities, materials, and techniques.	x							x					x	x	x	x			
2N035	Develop/enhance capabilities to identify and characterize improvised explosive devices (IED) and their associated networks.	x	x		x		x	x	x			x	x	x			x			
2N036	Develop/enhance capabilities to rapidly and accurately identify, classify, and count static and mobile equipment.	x					x		x							x	x			
2N048	Develop/enhance capabilities to detect and identify chemical agents, and associated delivery systems.		x	x	x									x			x		x	
2N049	Develop/enhance methods to identify and evaluate game-changing emerging technologies with dual-use potential.			x	x															x
2N050	Develop/enhance capabilities to detect biological agents and/or associated R&D that might cause deleterious alteration of the environment or deterioration of food, water, equipment, supplies, and/or material of any kind.	x		x			x		x			x					x			

Table 3.3 — **Multi-INT, IC-wide S&T Needs Best Addressed by Several IC Program Managers (*Category Two Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N051	Develop/enhance detection and monitoring of chemical weapon program activities, including Schedule 1 chemicals or precursors.				x		x		x			x		x		x	x			
2N052	Develop/enhance capabilities for defensive measures against nontraditional biological and chemical agents.	x		x	x				x					x			x			x
2N053	Develop/enhance detection capabilities to identify chemical weaponization.				x									x			x			
2N054	Develop/enhance methods to sample and analyze chemical weapons agents and their degradation products.				x							x		x			x			
2N058	Develop/enhance capabilities to rapidly characterize the release of chemical, biological, radiological, nuclear, and/or related hazardous materials.	x		x	x		x								x		x			
2N059	Develop/enhance capabilities to detect, track, and characterize vessels and other objects in the maritime domain.					x				x	x			x			x			
2N061	Develop/enhance capabilities to identify and protect critical assets, information systems, technologies, industries, and people.	x	x			x	x	x	x			x	x				x			
2N066	Develop/enhance capabilities to forecast global technological advances.	x					x		x								x			
2N068	Develop/enhance capabilities to detect and characterize cash smuggling, money laundering, and non-traditional means of exchange.	x	x			x	x	x	x				x				x			
2N069	Develop/enhance computational methods, including use of spatiotemporal data, to identify and characterize illicit trafficking (e.g., drugs, people, weapons, wildlife).	x	x			x	x						x				x			x

Table 3.3 — **Multi-INT, IC-wide S&T Needs Best Addressed by Several IC Program Managers (*Category Two Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N070	Develop/enhance technologies and methods that support mapping of RF telecommunications infrastructure.					x				x	x		x				x			
2N072	Develop/enhance capabilities to conduct detailed sampling and chemical analysis across all states of matter.				x		x		x		x	x		x			x			
2N073	Develop/enhance synthetic aperture radar capabilities and techniques.	x					x			x	x			x			x			
2N074	Develop/enhance LIDAR capabilities to generate photo-realistic visualizations and high-resolution models.						x		x	x				x			x			
2N077	Develop/enhance capabilities to characterize the space operating environment and improve global space situational awareness.						x		x							x	x	x		
2N078	Develop/enhance capabilities to track people, equipment, and material related to the illicit drug trade, WMD programs, and similar activities that threaten U.S. or Allied interests.			x	x				x				x	x	x		x			
2N080	Develop/enhance capabilities to identify new military applications of emerging technologies.	x	x	x	x		x					x					x		x	
2N086	Develop/enhance methods to engage and integrate multi-source data.	x	x					x	x			x	x							
2N087	Develop/enhance methods for high-volume data transfer.					x			x	x				x			x			
2N088	Develop/enhance means to locate and track mobile objects.				x	x		x		x			x	x			x			
2N094	Develop/enhance methods to characterize air, terrestrial, and maritime cargo transport through the integration of datasets.						x		x							x	x			

Table 3.3 — **Multi-INT, IC-wide S&T Needs Best Addressed by Several IC Program Managers (*Category Two Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N101	Develop/enhance automated methods to integrate unclassified sources of information (including fee-for-service products) to determine gaps and augment existing information holdings.	x					x		x											
2N103	Develop/enhance methods to verify the accuracy of information provided by nation states in arms control verification.	x			x	x		x	x						x					
2N109	Develop/enhance monitoring of global developments in cryptography.							x				x	x				x			
2N111	Develop/enhance capabilities to detect cyber compromises.							x	x			x								
2N114	Develop/enhance state-of-the-art signal processing technologies.					x	x	x	x	x	x			x			x			
2N115	Develop/enhance artificial intelligence and machine learning techniques for computer network defense.	x						x						x						
2N118	Develop/enhance biometric methods of identification from disparate datasets.	x					x	x	x			x	x				x			
2N120	Develop/enhance capabilities for document and media analysis.	x						x	x	x		x								
2N126	Develop/enhance capabilities and methods to identify and characterize the signatures and performance of weapons systems.	x			x		x		x			x		x	x		x			
2N127	Develop/enhance means to periodically search broad regions for specific but low signals.					x				x	x			x			x			
2N140	Develop/enhance digital processing capabilities to support current and emerging communication methods.					x	x	x	x	x	x									
2N145	Develop/enhance automated methods for biometric, chemical, biological, and radiological analysis.	x		x	x		x	x	x			x	x		x					

Table 3.3 — **Multi-INT, IC-wide S&T Needs Best Addressed by Several IC Program Managers (*Category Two Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N146	Develop/enhance understanding of background signatures for sensor platforms.	x		x	x				x					x			x			
2N148	Develop/enhance capabilities to identify physical and physiological signatures of deception.	x	x	x	x				x			x								
2N154	Develop/enhance capabilities to apply nontraditional biometric signatures to entity resolution.	x	x						x				x							
2N155	Develop/enhance capabilities to obtain high-quality biometrics for real-time identification.	x					x		x				x	x			x			
2N156	Develop/enhance author identification technologies from hand-written samples.	x	x				x						x							
2N157	Develop/enhance understanding of emerging biometric collection methodologies.			x		x		x				x	x	x						
2N158	Develop/enhance capabilities to electronically shield signals and protocols.					x	x	x	x	x				x						
2N160	Develop/enhance capabilities for improved communications with sensors (e.g., in high-interference environments).					x				x							x			
2N161	Develop/enhance capabilities to determine the origin of images or videos based on information contained within the media.	x					x	x	x			x				x	x			
2N162	Develop/enhance capabilities that link media to an author or origin.	x	x	x					x			x	x							
2N165	Develop/enhance understanding of emerging technical surveillance capabilities.		x							x		x	x				x			
2N171	Develop/enhance overhead communications infrastructure.					x				x	x			x			x	x		
2N172	Develop/enhance the accuracy and reliability of precision navigation and timing systems.						x				x			x		x	x	x		
2N179	Develop/enhance capabilities to detect submarine communications.					x				x	x						x			

Table 3.3 — **Multi-INT, IC-wide S&T Needs Best Addressed by Several IC Program Managers (*Category Two Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																		
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N180	Develop/enhance capabilities to detect and locate RF-based signals.					x				x	x						x			

CROSS-CUTTING S&T CHALLENGES REQUIRING WIDER GOVERNMENT PARTICIPATION (*CATEGORY THREE NEEDS*)

To meet many of the most pressing technical challenges of tomorrow, the IC S&T community requires an active global campaign of investigation, collection, and outreach, driven by an informed IC S&T strategy. The previous chapter demonstrated that despite the IC's breadth of capabilities, PMs will need to work together to face a wide range of difficult problems. To address a number of Needs, however, it is essential that the IC leverage resources outside of the Community, often to achieve new levels of scientific understanding.

Further analysis of the potential solutions to these Needs will therefore be required. The development of new techniques and enabling new partnerships to solve these Needs should be apparent, as is the opportunity to leverage existing resources into new cross-community programs. In resolving these challenges, STG encourages engagement with partners—such as the Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation (NSF), as well as Department of Energy (DOE) and DoD laboratories—to provide solutions to these increasingly intractable problems.

Table 3.4 — **Cross-cutting S&T Challenges Requiring Wider Government Participation (*Category Three Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N007	Develop/enhance methods to aggregate, analyze, and/or share financial data.	x					x	x	x			x								
2N015	Develop/enhance capabilities to identify social media moderators and/or network nodes, as well as understand the roles of influencers and controllers of information flow.	x	x			x		x	x				x							
2N023	Develop/enhance analytic tools to discover critical and non-traditional factors associated with extremist behaviors, radicalization, terrorist recruitment, and/or mobilization to violence.	x	x				x	x	x											x
2N024	Develop/enhance capabilities and/or methods to aggregate and analyze economic data.	x						x	x											
2N025	Develop/enhance theoretical concepts related to activity-based intelligence.	x	x			x	x	x	x								x			
2N029	Develop/enhance computational methods to automatically detect and quantitatively assess error propagation in aggregated disparate datasets to effectively represent and convey uncertainty and ambiguity.	x					x	x	x										x	
2N030	Develop/enhance Human Language Technology (HLT) tools to improve language identification, triage, gisting, summarizing, translation, and other language analysis tasks from multiple sources.	x	x			x		x	x								x		x	
2N038	Develop/enhance detection and characterization of undersea threats.									x	x			x		x	x			
2N039	Develop/enhance tools and capabilities to rapidly discover and analyze highly diluted information on social media.	x	x				x	x	x				x						x	x
2N045	Develop/enhance methods to characterize biological agents and/or their delivery systems from complex environmental backgrounds.	x		x			x					x		x			x			

Table 3.4 — **Cross-cutting S&T Challenges Requiring Wider Government Participation (*Category Three Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N046	Develop/enhance accredited forensic analysis tools and capabilities—to include a robust sampling and/or testing capability—to identify biological agents for early detection/ situational awareness.	x		x					x			x					x			
2N047	Develop/enhance capabilities to detect and characterize nonconsensual human omic modifications.	x	x	x			x					x					x			x
2N057	Develop/enhance capabilities for low-observable, all-weather, long-dwell platforms.					x				x	x						x			
2N060	Develop/enhance means to detect, track, and characterize objects and activities under natural and/or constructed canopies.			x					x					x			x			
2N067	Develop/enhance capabilities to detect, characterize, and track radionuclides and other nuclear materials.						x		x			x		x	x		x			
2N071	Develop/enhance the integration of signal processing, image, and video capabilities across multiple phenomenologies to improve situational awareness.						x		x	x				x			x			
2N076	Develop/enhance methods to detect interference with satellite operations.					x				x	x						x	x		
2N079	Develop/enhance capabilities to identify and characterize non-traditional IED materials and designs.				x								x	x	x		x			x
2N090	Develop/enhance methods to gather data from virtual environments, extract meaning, and correlate to people, places, and events in the physical world.	x	x				x	x	x				x				x			
2N091	Develop/enhance collaborative tools to conduct cross-discipline link-analysis, visualization, foreign-language translation, and geospatial and other technical analyses.	x					x		x							x				

Table 3.4 — **Cross-cutting S&T Challenges Requiring Wider Government Participation (*Category Three Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N095	Develop/enhance methods, tools, and capabilities to fuse and visualize vast quantities of diverse geospatial, temporal, and spectroradiometric data.	x					x		x											
2N096	Develop/enhance capabilities and methods to analyze, discover, extract, model, simulate, and/or visualize data in a spatiotemporal context from multiple domains and sources.	x					x		x				x				x			
2N097	Develop/enhance standards and methods to address challenges of processing, sharing, and analyzing spectral and spatiotemporal data within emerging high-performance computing and cloud architectures.	x				x	x		x	x										
2N098	Develop/enhance video and electro-optical processing capabilities that integrate computational analytic methods.	x					x		x				x							
2N113	Develop/enhance capabilities to identify supply chain vulnerabilities.	x							x	x		x	x	x			x			
2N117	Develop/enhance capabilities to detect and process evidence of WMD-related activities.	x		x	x							x	x		x		x			
2N134	Develop/enhance capabilities to characterize performance specifications of integrated circuits.						x			x	x	x		x						
2N150	Develop/enhance remote retrieval of biometric, identity, signatures, geospatial, and other data across multiple settings.					x				x			x	x		x	x			
2N152	Develop/enhance capabilities to attribute chemical, biological, radiological, nuclear, and explosive materials.			x	x				x			x			x					
2N173	Develop/enhance power source capabilities with improved energy density and increased cycle life.									x	x			x						
2N185	Develop/enhance understanding of quantum computing and quantum key management principles.						x	x												

Table 3.4 — **Cross-cutting S&T Challenges Requiring Wider Government Participation (*Category Three Needs*)**

NEED #	NEED DESCRIPTION	RELEVANT TECHNOLOGY DOMAINS																	
		ARTIFICIAL INTELLIGENCE	BEHAVIORAL SCIENCES	BIOLOGICAL SCIENCES	CHEMICAL SCIENCES	COMMUNICATIONS	COMPUTING	CYBER	DATA	ELECTRONICS	ENERGY AND POWER	FORENSICS	IDENTITY	MATERIALS AND MANUFACTURING	NUCLEAR SCIENCE	POSITION, NAVIGATION, AND TIMING	SENSORS	SPACE	SYSTEM OF SYSTEMS	OTHER
2N188	Develop/enhance sensor capabilities using novel materials.									x	x			x						x
2N190	Develop/enhance automated capabilities for in-scene analysis of full motion video.	x	x						x			x	x							

As the *Category Three Needs* are naturally more cross-disciplinary than those of *Categories One* and *Two*—often lying at the intersection of the responsibilities of at least several PMs across the NIP as well as performers outside of the IC—STG will seek to drive and champion a number of these Needs, subject to budgetary and staffing constraints, across the IC through FY2026.

Chapter 4
Conclusions and Next Steps

LEADING ENGAGEMENT AND DRIVING MISSION IMPACT ACROSS THE IC S&T ENTERPRISE

With the *Landscape* Needs as the rational, traceable, and defensible basis for engagement, the DS&T and STG will look to serve as the principal champion of creative, collaborative, IC-wide R&D efforts, recognizing the value of bottom-up, grassroots innovation across the Community and beyond. Importantly, STG will also serve as a critical means for the IC S&T enterprise to interact with partners across the U.S. industrial base—to include those in industry, academia, and elsewhere in government—as well as foreign partners.

- Over the next five years, the DS&T will pursue a new mechanism for resolving risk within the IC's S&T investment portfolio. Specifically, the DS&T will work with NISTC representatives to identify U.S. Government SMEs who can serve as champions for the *Landscape* Needs. In doing so, these SMEs will act as the conduits to help potential solvers in both the public and private sectors to better understand the requirements needed to resolve the technical challenges associated with their Needs.
- These identified SMEs will also work with the source(s) of the captured Need to confirm that the proposed solution adequately resolves the captured Need, and if necessary may seek funding from ODNI to assist with research to resolve the Need.

Through the *Landscape* and its follow-on products and activities, the IC S&T enterprise will usher in a new era of investments that address future research challenges, as identified by subject matter experts from industry and academia. The process will result in investment recommendations based on basic research challenges within partner-developed roadmaps to meet IC challenges for which existing or planned research efforts throughout industry and the U.S. Government are insufficient or cannot be otherwise leveraged.

Instantiating such a process for the IC S&T enterprise and broader U.S. Government to collaborate this way with academia and industry will achieve a truly unprecedented set of outcomes: an investment landscape of current and projected intelligence challenges as well as a research investment portfolio aligned to this same set of challenges. This approach will provide for a superior method for both the executive and legislative branches to determine the direction of broader national security enterprise challenges and for making resource allocation decisions to achieve the greatest intelligence advantage.

Through the output of this *Landscape*, the DS&T and the NISTC will make more informed investment recommendations to IC leadership, and to the White House's National Security Council (NSC), Office of Science and Technology Policy (OSTP), and Office of Management and Budget (OMB) regarding resource allocation to manage risk more effectively across the IC, a task that the Community is challenged to accomplish in a rational and defensible way with the tools and practices currently available.

Ultimately, key to the *Landscape's* success—and its defensibility to OMB and the Congress—will be the due diligence in first seeking to leverage or stimulate private-sector funding and, where market gaps and failures persist, to influence our nation's considerable public-sector funding in support of intelligence challenges. Only as a last resort should additional funding be used to address areas identified by industry experts as needed to meet intelligence challenges that are determined to be under-funded. Accordingly, such funded research results will be used for supplementing any longer-term, strategic planning efforts within the individual IC elements.

The *Landscape* provides the IC with the DS&T's strategic direction for the next five years, aligns IC priorities with other national strategies, and supports the IC's mission to provide timely, insightful, objective, and relevant intelligence to inform national security decisions and to protect our nation and its interests.

- The ODNI will assess IC element proposals, projects, and programs toward the objectives of the *Landscape* to realize the IC's vision of a nation made more secure by a fully integrated, agile, resilient, and innovative IC that exemplifies America's values.

Appendix
Acronyms List

AI	Artificial Intelligence
AVC	Department of State's Bureau of Arms Control, Verification, and Compliance
CIG	Consolidated Intelligence Guidance
DARPA	Defense Advanced Research Projects Agency
DNA	Deoxyribonucleic Acid
DNI	Director of National Intelligence
DoD	Department of Defense
DOE	Department of Energy
DS&T	Director of Science and Technology [ODNI]
EOP	Executive Office of the President
FM	Functional Manager
FPG	Fiscal and Procedural Guidance
FY	Fiscal Year
GEOINT	Geospatial Intelligence
GPS	Global Positioning System
HLT	Human Language Technology
IC	Intelligence Community
IED	Improvised Explosive Device
IoT	Internet of Things
IPG	Intelligence Planning Guidance
IPL	Integrated Priority List
IPPBE	Intelligence Planning, Programming, Budgeting, and Evaluation
IRAD	Independent Research and Development
LIDAR	Light Detection and Ranging
NIM	National Intelligence Manager [ODNI]
NIP	National Intelligence Program
NIS	National Intelligence Strategy
NISTC	Director of National Intelligence Science and Technology Committee [ODNI]
NSC	White House National Security Council
NSF	National Science Foundation
NSS	National Security Strategy
ODNI	Office of the Director of National Intelligence
OMB	White House Office of Management and Budget
OSTP	White House Office of Science and Technology Policy
PM	Program Manager
PNT	Precision Navigation and Timing
R&D	Research and Development
RF	Radiofrequency
S&T	Science and Technology
SIGINT	Signals Intelligence
SME	Subject Matter Expert
SoS	System of Systems
STG	Science and Technology Group [ODNI]

SWaP	Size, Weight, and Power
UCC	Unified Combatant Command
UIS	Unifying Intelligence Strategy
USG	United States Government
UTC	Coordinated Universal Time

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