April 10, 2019

**GAO Science, Technology Assessment, and Analytics Team:
Initial Plan and Considerations Moving Forward**

Introduction

The 2019 Legislative Branch Appropriations Bill Conference Report encouraged GAO to reorganize its technology and science function by creating a new office within GAO and to report to the Legislative Branch Appropriations Subcommittees on plans for doing so. In January 2019, we created the Science, Technology Assessment, and Analytics (STAA) team to build on our decades-long track record of providing Congress with science and technology (S&T) analysis.

Serving Congress

Science, technology, and information technology (IT) issues have figured prominently in the assistance we have provided to Congress via reports and other written products, direct technical assistance, and numerous testimonies. Our experts and products provide independent, nonpartisan analysis of complex S&T issues in direct service of Members of Congress and congressional staff. In fiscal year 2018 alone, we provided 34 congressional committees with **nearly 200 products**—including technology assessments (TA)—covering a wide range of science, technology, and IT issues, including cybersecurity. (See app. I for a list of selected key reports.) As the following examples illustrate, we have provided Members of Congress and staff with a variety of products and services on S&T topics.

- **Technology assessments.** Our 2018 TA on artificial intelligence (AI) outlined the potential policy implications of AI and was based on an expert forum we convened with participants from industry, government, academia, and nonprofit organizations. Topics of other recent TAs include sustainable chemistry, the Internet of Things, rapid diagnoses of infectious diseases, data analytics, and technologies to address municipal freshwater scarcity.

- **Technical assistance.** We frequently provide informal briefings and other assistance to Members of Congress and congressional staff on a very short time frame based on our expertise, work, and analysis. We have provided numerous technical briefings on request, such as on biodetection systems, big data, and artificial intelligence, among others. Our technical assistance also supports hearings. For example, we answered a request for technical assistance from the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce regarding fentanyl and fentanyl analogs for a hearing on the opioid crisis.

- **Oversight of federal technology and science programs.** Our recent federal S&T oversight work for Congress covered a range of topics, including maintaining U.S. competitiveness in quantum computing, synthetic biology, and other emerging technologies; biosafety and biosecurity; financial technology (fin tech) and regulatory oversight; electromagnetic risks to the electrical grid; border security technology; Department of Defense (DOD) use of commercial satellites; technology that tracks military aircraft; and the F-35 Joint Strike Fighter.

- **Best practices in engineering sciences.** We develop and utilize best practices in engineering sciences, including cost, schedule, and technology readiness assessments. We have used best practices guides to evaluate major technical systems acquisitions such as those found at DOD, the Department of Homeland Security (DHS), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and other agencies. For example, we are using our Technology Readiness Assessment Guide for an upcoming review of NASA major projects and used it to review the Columbia class ballistic missile submarine. We used our Schedule Assessment guide to review missile defense capabilities, and we used our Cost Estimating and Assessment guide to assess the reliability of cost estimates for defense infrastructure construction, uranium enrichment, and nuclear weapons systems.

- **Cybersecurity.** We work on how to protect the nation's critical infrastructure—including financial markets, telecommunications, the national airspace system, electricity grid, and oil and gas pipeline sector. We evaluate the cybersecurity of key federal agencies, such as the Internal Revenue Service (IRS) and DHS. We also evaluate federal efforts to ensure the privacy of individuals in response to emerging technologies (such as the Internet of Things and artificial intelligence), the collection and use of personal information in the private sector through social media, and privacy in government programs. Our recent work has included topics such as high-risk cybersecurity challenges facing the nation, DHS efforts to secure federal and private-sector networks, NASA cybersecurity, identity theft, DHS's cybersecurity workforce, and cybersecurity framework adoption by federal agencies for critical infrastructure protection.

The Road Ahead

We are implementing a number of steps that take into account unique requirements of technology assessments and related S&T work in order to meet the needs of Members of Congress and congressional staff. As we build on our existing capabilities and grow the new STAA team, we will focus on the following areas to continue and further enhance this line of work:
- development of additional product types and formats to ensure clear and concise communication on technical topics with quick turnaround;

- development of additional methods and standards that are appropriate to TAs and separate from those covering our audit work;

- designation of staff whose primary focus will be TAs and technical assistance;

- continued engagement with external experts and advisory boards, as appropriate; and

- development of policy options to provide Members of Congress and staff with a broader base of information for decision-making.

Moreover, with our plans to add staff to the new STAA team and to our Information Technology and Cybersecurity team in the coming year, we will expand our capacity for the S&T and IT work we already deliver for Congress.

In mapping out the direction for our expanded work, as of March 15, 2019, we have conducted more than 30 meetings and workshops with Members of Congress and staff; academic institutions with a nexus of science, engineering, and public policy; and other organizations that analyze policy or study science, technology, national security, and competitiveness. (See appendix II for a list of outreach we have conducted.) We will continue conversations with stakeholders as we grow and enhance our S&T and IT product and service lines.

The plan that follows (1) summarizes S&T trends relevant to our reorganization and planned expansion of capacity; (2) reviews our long-standing institutional experience in and capacity for providing S&T analysis for Congress; (3) explains the new team's structure, including current and planned resources, expertise, and staffing; (4) describes the S&T products and services our new team will offer Congress; and (5) provides an overview of governance structures related to our S&T work.

1. S&T Trends

Rapidly evolving developments in S&T trends are transforming multiple sectors of society, including medicine, transportation, communication, and even culture. These changes can potentially improve well-being, but they can also be disruptive. The ability of Congress to understand and evaluate such changes will be critical for the United States to remain safe, innovative, and globally competitive. In our 2018-2023 Strategic Plan for Serving Congress and the Nation, we outline trends that highlight a number of technologies and scientific advances that will potentially transform society, among them genome editing, artificial intelligence and automation, quantum information science, brain-computer interfaces and augmented reality, and cryptocurrencies and blockchain.[1] (See fig. 1.)

The speed and complexity of these advances bring proportionate challenges to policymakers. Moreover, gaps exist in federal programs' ability to address these changes and their ramifications. These factors underscore the need to ensure Congress can evaluate emerging and evolving technologies, assess their policy implications, foster their adoption when it is desirable, and protect the nation from any associated threats. Responding to this need, and reflecting congressional interest, our portfolio of S&T-related work has grown substantially over time.

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[1]GAO, *Strategic Plan 2018-2023: Trends Affecting Government and Society.* GAO-18-396SP. Washington, D.C.: Feb. 22, 2018.

Figure 1: Science and Technology Trends from GAO's 2018-2023 Strategic Plan for Serving Congress and the Nation

SCIENCE AND TECHNOLOGY

WHERE ARE WE?

Five emerging technologies will potentially transform society

1. Gene Editing

Gene editing: A technique used to make specific and intentional additions, deletions, or alterations to genetic material.
It could:
- prevent, treat, or cure medical conditions
- create unintended and unforeseen genetic changes in the population

2. Artificial Intelligence and Automation

Artificial intelligence (AI) could:
- produce smarter machines that perform more sophisticated tasks
- disrupt the job market by eliminating jobs and creating others with new skill requirements

While its use is expected to grow, AI that is as intelligent as a human is not expected to occur in the next 20 years.

3. Quantum Information Science

Quantum information science: uses the behavior of atoms or molecules to obtain and process information in ways that existing systems cannot.
It could:
- drastically improve information acquisition, processing, and transmission.

4. Brain/Augmented Reality

Brain-computer interfaces: systems that connect the human brain to an external device. Research is ongoing to create implantable versions that could, for example, compensate for vision loss or hearing impairment.

Augmented reality: superimposing a digital image onto a view of the real world through a device, such as a smartphone camera. It is a new trend in entertainment, education, and healthcare.

5. Cryptocurrencies and Blockchain

Cryptocurrencies: virtual currencies—digital representations of value that are not government-issued—that operate online and verify transactions using a public ledger called **blockchain**.

Cryptocurrencies offer:
- benefits such as anonymity and lower transaction costs
- drawbacks such as making it harder to detect money laundering and other financial crimes

Blockchain could:
- reshape financial services
- have more security vulnerabilities as quantum computing, an area of quantum information science, develops

WHAT ARE THE IMPLICATIONS?

Continued **debate, study, and evaluation** are needed in the public sector to consider the potential implications:

economic   ethical   privacy   safety   security   societal

Source: GAO.

GAO Science and Technology Reorganization

2. Demonstrated Ability to Provide S&T Analysis to Congress

We have a long track record of doing science and technology related work, including conducting technology assessments, for congressional committees and their staff dating back to the 1990s. GAO defines technical assessments as a separate product line that provides insight and foresight to Congress by explaining a specific technology's policy implications and its potential effects on government and society. GAO has demonstrated its ability to (1) produce science and technology assessments; (2) develop and apply technology readiness assessments; (3) evaluate management of federal technology and science programs; and (4) evaluate complex and growing cyber security risks, including efforts to protect cyber critical infrastructure and data, privacy, and personally identifiable information.

Our involvement in technology assessments has evolved over time. For example:

- In 1997, we first designated information security as a government-wide high-risk area.

- In 2000, we established the Center for Technology and Engineering, led by the position of Chief Technologist, in the Applied Research and Methods team. This center later became the Center for Science, Technology, and Engineering.

- In 2001, we started a standing task order contract with the National Academies of Sciences, Engineering, and Medicine. GAO can interact with National Academies personnel to help GAO identify experts on various scientific topics and also can leverage National Academies assistance to convene GAO expert meetings.

- In 2002, Congress asked us to begin conducting technology assessments to provide more in-depth analysis of technical and scientific issues in order to support congressional decision making.

- In 2003, we expanded the information security high-risk area to include protecting cyber critical infrastructure.

- From 2002-2006, in response to the Committee's direction to establish a technology assessment pilot program, we completed several technology assessments; based on the positive response to this pilot program, the appropriations committees asked us to continue conducting technology assessments on a permanent basis.

- The Senate report accompanying the Senate's legislative branch appropriations bill for fiscal year 2008 recommended the establishment of a permanent technology assessment function within GAO, stating that "GAO's focus on producing quality reports that are professional, objective, fact-based, fair, balanced, and nonpartisan is consistent with the needs of an independent legislative branch technology assessment function."

- In 2007-2008, in the 2008 Consolidated Appropriations Act, the Congress authorized GAO to use up to $2.5 million of amounts appropriated for salaries and expenses for technology assessment studies. We created the role of Chief Scientist and Congress authorized GAO's technology assessment program on a permanent basis.

- In 2015, we expanded the cybersecurity high-risk area again to include protection of personally identifiable information.

- In January 2019, we created the Science, Technology Assessment, and Analytics Team by combining and enhancing technology assessment functions and science and technology evaluation into a single, more prominent office to expand GAO's support to lawmakers on cutting-edge topics, such as artificial intelligence, regenerative medicine, 5G wireless communication, and quantum computing.

In addition, GAO's S&T and cybersecurity work has been used widely by Members of Congress and congressional staff as they work to address major national challenges. For example, our cybersecurity work has contributed to major legislation on information security, including the Federal Information Security Management Act of 2002 (FISMA), the subsequent amendment to FISMA in 2014, and the Federal Cybersecurity Enhancement Act of 2015.

Technology Assessments

Independent from oversight activities, our TAs are a separate product line that provides insight and foresight to Congress by explaining a specific technology's policy implications and its potential effects on government and society. (See table 1 for a list of TAs.) Topics covered by our TAs have included:

- **Digital innovation and competitiveness:** artificial intelligence, the Internet of Things, innovation in data analytics, and 3D printing;

- **Energy and environment:** sustainable chemistry, technologies to address municipal freshwater scarcity, reducing freshwater use in hydraulic fracturing and thermoelectric power plant cooling, climate engineering, and advanced nuclear reactors;

- **Health care:** enabling rapid diagnoses of infectious diseases, and the implications of nanomanufacturing on human health; and

- **Homeland security:** use of explosives detection technologies to protect passenger trains, the use of biometrics for border security, and cybersecurity for critical infrastructure protection.

Table 1: Technology Assessments and Science Forum Highlights

Artificial Intelligence: Emerging Opportunities, Challenges, and Implications, GAO-18-142SP (Mar. 28, 2018)	*A Capsule Version of Nanomanufacturing—Emergence and Implications for U.S. Competitiveness, the Environment, and Human Health,* GAO-14-406SP (May 19, 2014)
Chemical Innovation: Technologies to Make Processes and Products More Sustainable, GAO-18-307 (Feb. 8, 2018)	*Nanomanufacturing: Emergence and Implications for U.S. Competitiveness, the Environment, and Human Health* GAO-14-181SP (Jan. 31, 2014)
Medical Devices: Capabilities and Challenges of Technologies to Enable Rapid diagnoses of Infectious Diseases, GAO-17-347 (Aug. 14, 2017)	*Neutron Detectors: Alternatives to Using Helium-3,* GAO-11-753 (Sept. 29, 2011)
Internet of Things: Status and Implications of an Increasingly Connected World, GAO-17-75 (May 15, 2017)	*Climate Engineering: Technical Status, Future Directions, and Potential Responses,* GAO-11-71 (July 28, 2011)
Highlights of a Forum: Data and Analytics Innovation— Emerging Opportunities and Challenges, GAO-16-659SP (Sept. 20, 2016)	*Explosives Detection Technologies to Protect Passenger Rail,* GAO-10-898 (July 28, 2010)
Municipal Freshwater Scarcity: Using Technology to Improve Distribution System Efficiency and Tap Nontraditional Water Sources, GAO-16-474 (Apr. 29, 2016)	*Securing the Transport of Cargo Containers,* GAO-06-68SU (Jan. 25, 2006)
Municipal Freshwater Scarcity: Survey of Technology Adoption by Municipal Water Utilities (GAO-16-588SP, Apr. 29, 2016), an e-supplement to GAO-16-474	*Protecting Structures and Improving Communications during Wildland Fires,* GAO-05-380 (Apr. 26, 2005)
Water in the Energy Sector: Reducing Freshwater Use in Hydraulic Fracturing and Thermoelectric Power Plant Cooling, GAO-15-545 (Aug. 7, 2015)	*Cybersecurity for Critical Infrastructure Protection,* GAO-04-321 (May 28, 2004)
Nuclear Reactors: Status and Challenges in Development and Deployment of New Commercial Concepts, GAO-15-652 (July 28, 2015)	*Using Biometrics for Border Security,* GAO-03-174 (Nov. 15, 2002)
Highlights of a Forum: 3D Printing: Opportunities, Challenges, and Policy Implications of Additive Manufacturing, GAO-15-505SP (June 24, 2015)	

Source: GAO.

Best Practices Guides

In response to persistent challenges in managing the cost, schedule, and performance of the federal government's significant investments in research and development and complex technical acquisition programs, we developed a series of best practices guides that lay out proven and effective approaches and decision-making tools for federal managers. Our best practices guides currently cover cost, schedule, and technology readiness, with an additional guide planned for Agile software development.

We develop and validate each best practices guide in consultation with a community of subject matter experts from government, university, industry, and nonprofit sectors who routinely meet to discuss the criteria in these guides and share case studies concerning lessons learned in the field of practice. As the regular meeting host, we capture key discussion points of each meeting and over time are able to identify and formulate the best practices in each discipline and codify them in our guide. After coordinating the content with our experts, we release a public exposure draft of the best practices guide

for a period of 1 to 2 years, during which time input and feedback is sought from all interested parties, including members of the public, private companies, trade industry groups, university researchers, government agencies, and government working groups. Once the comment period closes, we vet each comment and incorporate the input as appropriate in order to develop the finished guide.

Our cost, schedule, and technology readiness assessment guides have improved project management practices across the federal government and spurred congressional action on technology risks. The Cost Estimating and Assessment Guide gained government-wide prominence when the Office of Management and Budget based its cost estimating guidance for federal capital acquisition projects on it. The National Science Foundation, Federal Railroad Administration, and Missile Defense Agency are examples of agencies that have aligned their cost estimating guidance to GAO's cost estimating best practices. Moreover, the cost guide has been translated into foreign languages and is used in various countries around the World.

We have used our best practices guides to evaluate acquisitions by agencies, including

- Department of Defense,

- Department of Homeland Security,

- Department of Energy, and

- NASA.

For example, we have evaluated the technology readiness assessments and overall project execution for border security technology, complex weapons systems such as the Columbia class ballistic missile submarine, and military space systems.

Evaluations of Federal Technology and Science Programs

We evaluate the management and coordination of federal research and development efforts across a number of domains, such as defense, space, energy and environment, health care, basic science, innovation, and economic competitiveness (see fig. 2). Recent work in this area has covered investments in scientific facilities (such as telescopes and research vessels) and emerging technologies (such as synthetic biology and quantum computing), among others.

Figure 2: Management of Federal Technology and Science Programs
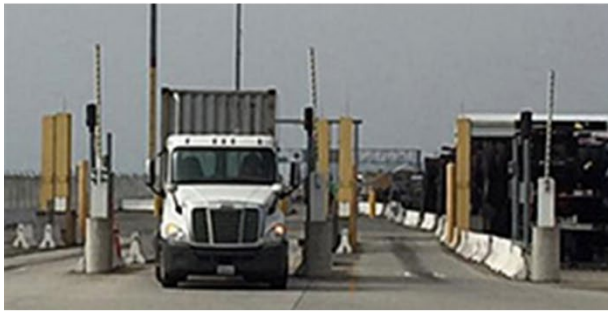
Defense

We evaluate the technology readiness assessments and overall project execution for complex weapons systems, such as the Columbia class ballistic missile submarine, military space systems, and border security technology.

Space

We assess federal military and civilian satellite programs and efforts to support and oversee telecommunications in the public interest.


Energy and the environment

We evaluate developing and deployed technologies in a range of activities, including renewable energy, civilian nuclear power, and cleanup of hazardous waste sites.

Sources (top to bottom): GAO, NASA, and GAO.

Part 1 of 2

Nuclear

We assess programs, infrastructure, technology readiness, and operations for the maintenance and management of nuclear weapons and missiles, as well as the aircraft and ships designed to carry and deliver them.
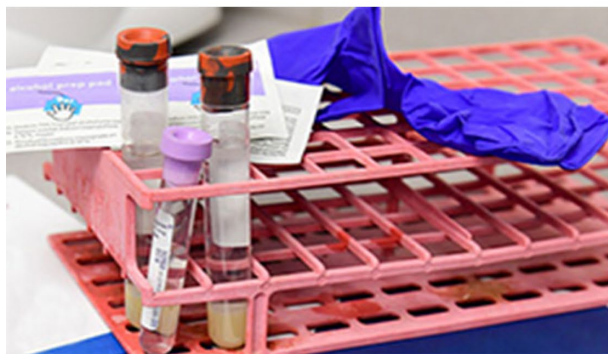
Health care

We assess new technologies for emerging infectious diseases, such as technologies that can simultaneously test for multiple infectious diseases at or near the site of patient care, and the impacts of new technology on human health, disease prevention, and the delivery of health care.

Science and innovation

We assess programs to promote innovation (such as federal support for advanced manufacturing institutes), as well as federal policies and funding for the protection of intellectual property.

Sources (top to bottom): GAO, GAO, and NIST Manufacturing Extension Partnership.   Part 2 of 2

<u>Evaluations of Cybersecurity Threats</u>

Federal agencies and the nation's critical infrastructure—such as energy, transportation systems, communications, and financial services—depend on cyber information systems and information technology to carry out operations and to process, maintain, and report essential information. Our work in cybersecurity includes:

- **Critical infrastructure protection**. We work on how to protect the nation's critical infrastructure—including financial markets, telecommunications, the national airspace system, electricity grid, and oil and gas pipeline sectors.[2]

- **Federal information systems**. We evaluate the cybersecurity of key federal agencies, such as IRS, DHS, and the Department of Health and Human Services.

- **Privacy**. We evaluate federal efforts to ensure the privacy of individuals in response to emerging technologies (such as the Internet of Things and artificial intelligence), the collection and use of personal information in the private sector through social media, and privacy in government programs (e.g., federal student aid and Medicare).

We recently updated our cybersecurity high-risk area to highlight urgent actions that are needed by federal agencies to ensure the cybersecurity of our nation. (See fig. 3.)

We also renamed our Information Technology team to Information Technology and Cybersecurity (ITC), to better reflect our significant body of work on protecting federal information systems, critical infrastructure, and individual privacy and sensitive data from cyber threats. In addition to staff increases in the new STAA team (see section 3 below), our ITC team plans to increase its FTE count by 30-35 to reach approximately 175 people by the end of fiscal year 2019.

ITC team members have extensive knowledge of key IT domains, including IT & cybersecurity risk management, software development, system administration, and computing networking. In addition, the ITC team has extensive experience in assessing cybersecurity practices, including efforts to identify, detect, and prevent cybersecurity threats (e.g., adversarial tactics, techniques, and procedures), identity management and access control, data security, security management processes, event monitoring, and incident detection. Many ITC team members have one or more specialized certifications, including Certified Information Systems Security Professional (CISSP), Certified Information Privacy Professional (CIPP), Certified Information Systems Auditor (CISA), Certified Ethical Hacker (CEH), and Program Management Professional (PMP), among others.

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[2]Federal policy identifies a total of 16 critical infrastructure sectors: chemical; commercial facilities; communications; critical manufacturing; dams; defense industrial base; emergency services; energy; financial services; food and agriculture; government facilities; health care and public health; information technology; nuclear reactors, materials, and waste; transportation systems; and water and wastewater systems.

Figure 3: Ten Critical Actions Needed to Address Four Major Cybersecurity Challenges

Major challenges

Critical actions needed

Establishing a comprehensive cybersecurity strategy and performing effective oversight

Develop and execute a more comprehensive federal strategy for national cybersecurity and global cyberspace.

Mitigate global supply chain risks (e.g., installation of malicious software or hardware).

Address cybersecurity workforce management challenges.

Ensure the security of emerging technologies (e.g., artificial intelligence and Internet of Things).

Securing federal systems and information

Improve implementation of government-wide cybersecurity initiatives.

Address weaknesses in federal agency information security programs.

Enhance the federal response to cyber incidents.

Protecting cyber critical infrastructure

Strengthen the federal role in protecting the cybersecurity of critical infrastructure (e.g., electricity grid and telecommunications networks).

Protecting privacy and sensitive data

Improve federal efforts to protect privacy and sensitive data.

Appropriately limit the collection and use of personal information and ensure that it is obtained with appropriate knowledge or consent.

Source: GAO analysis.

With the expertise of the ITC team, we will continue to focus on evaluating efforts to protect federal systems, critical infrastructure, and individual privacy from cyber threats and other risks. In our work this year, we recommended that Congress consider legislation to strengthen the consumer privacy framework to reflect the effects of changes in technology and the marketplace.

Over the next 2 years, our planned work in cybersecurity will continue to focus on critical infrastructure protection and privacy, including assessing the federal government's efforts to establish and implement a comprehensive national and global cyber strategy; evaluating government-wide initiatives to implement continuous diagnostics and monitoring capabilities; and reviewing efforts to establish effective risk-management processes at federal agencies. We are also evaluating key agency capabilities for responding to security incidents and data breaches, as well as assessing their security postures through detailed vulnerability assessments of agency network defenses.

3. New Science, Technology Assessment, and Analytics Team

To enhance our ability to provide Congress with thorough and balanced analysis of technological and scientific developments that affect our society, environment, and economy, we reorganized in January 2019 to create the STAA team. This reorganization involves reallocating existing staff and hiring new staff, which was possible because of the funding we received in accordance with our fiscal year 2019 budget proposal.

Our vision for STAA is informed by discussions with external stakeholders, including Members of Congress, congressional staff, and other external experts in S&T issues. STAA will provide evidence-based analysis that helps position the federal government to make important decisions on S&T advancements. Our analyses will help improve IT and defense technology acquisitions, national security, and other programs. The work we conduct will ensure that federal investments in research, development, and advanced manufacturing are focused on improving U.S. economic competitiveness and making the best use of advancements in areas such as health care, energy, and space science.

Figure 4 shows the range of products the team will provide, recent examples, and ongoing work coming from the new mission team.

**Figure 4: Range of Science, Technology Assessment, and Analytics (STAA) Team Products**

GAO
TECHNOLOGY & SCIENCE

GAO produces several types of products on science, technology, innovation and competitiveness issues. STAA will continue to provide critical oversight, insight, and foresight on these issues for GAO and the Congress.

What are STAA's product types?

Technology assessments provide thorough and balanced analysis of critical technological innovations that affect our society, the environment, and the economy.

Performance audits assess the efforts of federal science agencies to plan, manage, and evaluate research activities; protect and manage intellectual property developed with federal funding; and enhance U.S. growth and competitiveness through innovation and technological advancement.

Best practice guides in the engineering sciences are used to review agency cost estimates and schedules for their adherence to best practices in lifecycle cost estimating, schedule and schedule risk analysis, and technology readiness assessment, among others.

What are some recent examples?

- **Artificial Intelligence Technology Assessment** (GAO-18-142SP)
- **Sustainable Chemistry Technology Assessment** (GAO-18-307)
- **Internet of Things Technology Assessment** (GAO-17-75)
- **Next Generation Medical Devices Technology Assessment** (GAO-17-347)

- **High-Containment Laboratories** (GAO-18-145)
- **U.S. Competitiveness in Quantum Computing, Synthetic Biology, and Other Areas** (GAO-18-656)
- **Covered Business Method Patent Review Program** (GAO-18-320)
- **National Science Foundation Workforce** (GAO-18-533)

- **2020 Census Scheduling Progress** (GAO-18-589)
- **Columbia Class Submarine** (GAO-18-158)
- **NASA: Assessments of Major Projects** (GAO-18-280SP)

What are examples of ongoing work?

Water Use in Agriculture Technology Assessment

Artificial Intelligence in Health Care Technology Assessment

5G Wireless Communications Technology Assessment

Federal Efforts to Address Sexual Harassment in Science

Antibiotic-resistant Bacteria

Access to Federally Funded Research and Data

Cost and Schedule of National Science Foundation's Large Facilities Projects

Source: GAO.

Team Structure

The STAA team includes technical specialists and policy analysts across four groups, as shown in figure 5, as well as administrative staff. The team is headed by two managing directors, John Neumann and Tim Persons. Dr. Persons is also our Chief Scientist. The new team will have four components:

(1) the Technology Assessment and Technical Assistance group (scientists and engineers across a range of specialties), which was formerly part of our Center for Science, Technology, and Engineering (CSTE) in our Applied Research and Methods team;

(2) the Engineering Sciences group (operations researchers with expertise in cost, schedule, and technology readiness assessments), which was also formerly part of CSTE in our Applied Research and Methods team;

(3) the Science and Technology Program Oversight group, which was formerly part of the Natural Resources and Environment team, and will be staffed by policy analysts from across our mission teams with experience in auditing a wide range of science and technology-related federal programs; and

(4) an Innovation Lab, which is a new initiative launched as part of the reorganization.

Figure 5: Organizational Structure of the New Science, Technology Assessment, and Analytics Team
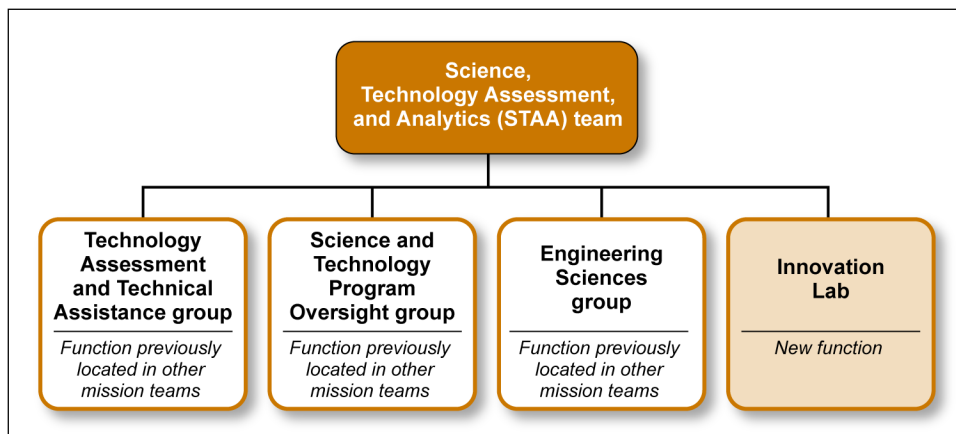
Source: GAO.

By utilizing staff from across GAO in a number of disciplines and by locating science and technology-focused staff in one team, this new team structure leverages significant synergies. The programmatic and policy knowledge of our analysts will sit alongside experts with deep knowledge in scientific and technical fields. An internal team of attorneys has also been assigned to the STAA team. Further, STAA staff will collaborate with our broader workforce of subject-area policy analysts, economists, social scientists, methodologists, attorneys, and other experts. In addition, GAO's 11 field offices, located across the country, allow us to have deeper links throughout the federal community, draw talent from different regions of the country, and maintain connections with a diverse set of universities and research institutions. These approaches bring a powerful and sophisticated perspective to our work as we conduct TAs and analyze the policy

implications of a range of technical and scientific topics for Members of Congress and congressional staff.

Staffing and Expertise

We plan to significantly grow our current combined S&T workforce over the next few years. The functions to be housed under the STAA team currently total 49 full-time equivalent (FTE) staff. We plan to grow this staffing in fiscal year 2019 to reach an initial target staffing level of 70 FTE, as shown in figure 6. We estimate the fiscal year 2020 annual salary and benefits costs for the STAA team will be approximately $15 million. Overall, as we adapt to future demand and gauge the number and type of TAs and technical assistance requests from Congress, as many as 100 to 140 total staff may be needed in future years.

Figure 6: Current Staff Levels and Planned Increases through Fiscal Year 2019

GAO plans to double the size of its current science and technology workforce in order to significantly expand the level of support we can provide to the Congress.

What is the current and future staffing?[a]

Technology Assessment and Technical Assistance:

Science and Technology Program Oversight:

Engineering Sciences:

Innovation Lab:

Current full-time equivalent (FTE) staffing

Planned increase in FTE staffing, fiscal year 2019

What are the areas of focus for near-term hiring?

- Biological/life sciences for emerging and infectious diseases, epidemiology, synthetic biology, and biosafety and biosecurity work
- Computer/systems/electrical engineering for digital and communication technologies such as 5G wireless, Blockchain, quantum cryptography, artificial intelligence, and machine learning systems
- Applied math/statistics/computer science for advanced analytics, data science, and data engineering
- Nuclear physics for nuclear nonproliferation, waste management, weapons system analysis, radiation and nuclear detection systems, and quantum computing
- Physics/aerospace engineering for hypersonics, advanced weapons systems, space systems, and unmanned systems

Source: GAO.

[a]The figure does not include 5 FTE for administrative and support staff; two managing directors; or limited-term subject matter expert (SME) staff, as appropriate, to meet project-specific needs.

This growth will build on an already strong foundation of expertise. The Technology Assessment and Technical Assistance group currently includes engineers (e.g., biomedical, electrical and electronics, chemical, petroleum), chemists (e.g., analytical, environmental, inorganic, organic, theoretical), physicists including nuclear physics, an environmental scientist, and a geologist, among others. In addition, the Engineering Sciences group consists of operations research analysts who specialize in lifecycle cost estimating, scheduling, earned value management, and technology readiness assessment.

We will continually assess optimum staffing levels for the team based on congressional needs, product demand, and other factors. As we continue to assess anticipated future work and S&T issues that will be of interest to the Congress, we plan to focus hiring to add expertise in biological sciences, nuclear physics, space science, and data analysis, as well as expand our core group of analysts. Limited-term staff will be added on a project-specific basis to meet needs for specialized expertise.

To bolster the new team, we have begun efforts to recruit additional staff with expertise in:
- biological/life sciences for emerging infectious diseases, epidemiology, synthetic biology, biosafety, and biosecurity work;

- computer/systems/electrical engineering for digital and communications technologies (i.e., 5G wireless, blockchain, quantum cryptography, artificial intelligence/machine learning systems);

- applied math/statistics/computer science for advanced analytics/data science/data engineering;

- nuclear physics for nuclear nonproliferation, waste management, weapons systems analysis, and radiation/nuclear detection systems;

- quantum computing; and

- physics/aerospace engineering for hypersonics, advanced weapons systems, space systems, and unmanned systems.

In addition to the permanent staff for STAA's four core groups, we are exploring additional flexibilities that would allow us to actively recruit staff to meet project-specific needs. Such staff could include undergraduate and graduate interns and Intergovernmental Personnel Act detailees.[3] The exact number of such staff will vary based on our legal flexibilities, project needs, and congressional demand for our work. We will seek additional hiring authorities if necessary to obtain needed expertise. As discussed during meetings with external stakeholders, there is a strong interest within the S&T community in opportunities to participate in and contribute to analysis of S&T issues on behalf of the Congress, and to enhance their own work on S&T issues through an understanding of the broader policy context.

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[3]The Intergovernmental Personnel Act Mobility Program provides for the temporary assignment of personnel between the Federal Government and state and local governments, colleges and universities, Indian tribal governments, federally funded research and development centers, and other eligible organizations. Assignment agreements can be made for up to two years, and may be intermittent, part-time, or full-time.

Further, GAO regularly engages with the National Academies of Sciences, Engineering, and Medicine through a standing task order contract. Under this contract, which started in 2001, GAO interacts with National Academies personnel to help GAO identify experts on various scientific topics and also leverages National Academies assistance to convene GAO expert meetings. Additionally, we have engaged with and plan to remain connected to federally funded research and development centers (FFRDCs), such as the MITRE Corporation, the Institute for Defense Analyses, and the Carnegie-Mellon Software Engineering Institute, among others. We are also building key academic partnerships with universities that have specialized programs in science, technology, and public policy, such as Arizona State University, Carnegie-Mellon University, the Georgia Institute of Technology, the Massachusetts Institute of Technology, and University of Maryland College Park, among others.

Timelines

In fiscal year 2019, we will continue our outreach to Members of Congress, staff, and external stakeholders; manage the reassignment of existing GAO staff and hiring of new staff into the STAA team; and establish an S&T advisory board.[4] We have also incorporated the new team's activities into our fiscal year 2020 budget request and performance plan.

4. STAA Team Products and Services for Congress

To help ensure Members of Congress and congressional staff continue to have access to independent, nonpartisan analysis of high-impact technological and scientific topics affecting society, security, and U.S. competitiveness, the STAA team will focus on four key areas:
- technology assessments and providing technical assistance for Members of Congress and staff;

- evaluation of S&T programs within the federal government;

- best practices guides in the engineering sciences, including cost, schedule and technology readiness assessments; and

- an innovation lab to explore, pilot, and deploy new advanced analytic capabilities and emerging technologies.

Figure 7 provides a summary of the services we will provide to Congress. Notably, the STAA team will identify and analyze policy options in future technology assessments, where appropriate, to inform and support policy decisions. Our past TAs have discussed policy implications, and moving forward we will incorporate policy options where warranted. This shift is based on feedback we have heard in meetings with Members of Congress and congressional staff, as well as with other external stakeholders. We will provide fact-based, nonpartisan analysis of the potential benefits and tradeoffs

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[4]The S&T advisory board will consist of external S&T policy experts from industry, academia, nonprofits, and former senior government officials. See section 5 "Governance Structures for Our S&T Work" for more information.

associated with each option. Overall, the work of the four groups in the STAA team, described in detail below, will greatly enhance the S&T support we provide to Congress.

Figure 7: Current and Planned Capabilities of Our Science, Technology Assessment, and Analytics Team

GAO expects to expand the number of products and increase the amount of assistance it currently provides to Congress on science and technology issues.

Products and services	Current capabilities	Projected capabilities
Technology assessments	✔	✔ Increased
Science and technology program audits	✔	✔ Increased
Science and technology support for other GAO reports	✔	✔ Increased
Cost, schedule, and technology readiness assessments	✔	✔ Increased
Ad hoc technical assistance[a] to congressional committees, subcommittees, and individual Members	✔	✔ Increased
Policy implications of emerging technologies	✔	✔ Increased
Provide policy options in our technology assessments		✔
Innovation in data analysis and audit practices		✔
New product types produced in shorter time frames		✔

Source: GAO.

[a]Note: Technical assistance is a type of nonaudit work provided to Congress in a very short time frame based on GAO's work or analysis. Briefings may be used as a means to provide technical assistance.

GAO Science and Technology Reorganization

Technology Assessment and Technical Assistance. Scientists and engineers with expertise across a range of fields will staff this group. Prior to the reorganization, this group:

- issued one to three major technology assessments plus one to three science and technology-focused audits per year;

- through scientific research, advice, and written materials, supported more than 100 reports annually covering federal programs with a science or technology component;

- provided on-demand technical assistance to individual Members, committees, and subcommittees on S&T topics.

Ongoing and planned technology assessments in fiscal year 2019 include applications of artificial intelligence in health care, freshwater technologies in agriculture, and 5G wireless communications systems. Based on interest expressed by various committees of jurisdiction, potential future work could focus on digital ledger technologies such as blockchain, opioid-addiction vaccine development, autonomous vehicles, and regenerative medicine, among many others.

In addition, this group is exploring new product formats to complement current ones in order to meet the needs of Members of Congress and congressional staff. New products are likely to include one- or two-page briefs highlighting key findings of recently issued reports or explaining the basics of timely S&T topics; potential questions for upcoming hearings based on our prior work; or shorter, more narrowly-focused technology assessments.

S&T Program Oversight. Policy analysts with experience in auditing a wide range of science and technology-related federal programs staff this group. Prior to the reorganization, this group:

- issued nine or more S&T-related performance audits per year, on topics such as federally funded research and development programs, efforts to transfer federally funded research to the commercial sector, protection and management of intellectual property, and programs to promote innovation and technological advancement;

- provided on-demand technical assistance to individual Members, committees, and subcommittees on these topics;

- partnered with the Technology Assessment and Technical Assistance group on technology assessments; and

- provided support to other GAO mission teams on cross-cutting S&T issues.

Engineering Sciences. Operations research analysts with expertise in cost estimating, schedule analysis, and technology readiness assessments staff this group. These staff assess the extent to which agency cost estimates and master schedules adhere to the best practices published in GAO's Cost Estimating and Schedule Assessment Guides. They also determine the quality of agency technology readiness assessments using

GAO's Technology Readiness Assessment Guide.[5] A technology readiness assessment (TRA) is a systematic, evidence-based process that evaluates the maturity of hardware and software technologies critical to the performance of a larger system or the fulfillment of the key objectives of an acquisition program. The Technology Readiness Assessment Guide has been used to assess the Columbia class ballistic missile submarine and is currently being used in our upcoming 2019 review of major NASA projects.

This group is also in the process of jointly developing an Agile Assessment Guide with the ITC team that will provide criteria for audits and guidance to agencies regarding Agile adoption, contracting for Agile projects, and using program controls to help manage Agile projects.

Future efforts would expand and accelerate our work to potentially include technology readiness assessments of complex acquisitions such as nuclear modernization programs, the Army's Next Generation Combat Vehicle program, DHS border protection technologies, and the Uranium Processing Facility.

Innovation Lab. Data scientists, statisticians, and operations researchers will staff the Innovation Lab, a new initiative. The lab's staff will leverage people, data, technology, and new processes to explore and pilot new advanced analytic capabilities, emerging technologies, and innovative audit practices. They will also partner with other GAO teams to develop new, data-based audit methods and frameworks that allow the use of new data analytics capabilities in audits. Specifically, the Lab will focus on developing capabilities in four key areas:

1. **Advanced analytics.** The use of analytical methods, skills, and capabilities to discover and visualize patterns and trends in structured, unstructured, and disparate data sets to efficiently and effectively produce insights not possible or feasible through conventional methods alone.
2. **Data science.** Technical enhancements for the preparation, processing, and storage of large and/or heterogeneous datasets. Achieving such integration will allow us to conduct more complex analysis and better assess relationships among data elements.
3. **Information assurance research.** The development of enhanced technical expertise in information and system security, including cryptography, techniques for auditing cloud-based IT systems and cyber-physical systems (e.g., Internet of Things and "smart" devices), and standards based on established NIST, DHS, or DOD frameworks.
4. **Emerging technologies.** Monitoring of new and emerging technologies relevant to financial auditing, including artificial intelligence, machine learning, and new computational techniques.

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[5] The Technology Readiness Assessment Guide (GAO-16-410G) currently is available publicly as an exposure draft.

5. Governance Structures for Our S&T Work

A number of governance processes and structures exist at GAO that apply to the new STAA team. These include our statutory independence, Congressional Protocols, external advisory boards, and quality assurance processes such as peer review.

Independence. Our position in the legislative branch of federal government creates independence from the executive branch. Further, we have specific authorities to conduct analysis when ordered by either house of Congress, when requested by a committee of jurisdiction, or on the initiative of the Comptroller General. In fiscal year 2018, we devoted 97 percent of our engagement resources to work requested directly by the Congress or required by statute. We devoted the remaining 3 percent of engagement resources to work initiated under the Comptroller General's authority. We have a number of internal processes and policies designed to help assure our independence.

In addition, the independence of the Comptroller General position and the position's unique appointment process are important parts of the governance structure for GAO. When a vacancy occurs in the office of the Comptroller General, the Congress establishes a 10-member bipartisan, bicameral commission to recommend individuals to the President. The Comptroller General is then appointed by the President with the advice and consent of the Senate. The Comptroller General's term of office is set statutorily at 15 years without the possibility for reappointment. During the term of office, the Comptroller General works in a nonpartisan and nonideological manner with Members of Congress and congressional staff. Further, the Comptroller General can only be removed from office by the Congress, not by the President.

Congressional Protocols. Designed in consultation with Congress, the Congressional Protocols, as originally issued in 2000 and updated in 2004 and 2017, have been effective in allowing us to work constructively with Congress and conduct our work in accordance with congressional priorities. Our S&T work for Congress adheres to same principles that govern all of our work: a commitment to nonpartisan, independent, and fact-based analysis. Moreover, our S&T work has been and will continue to be conducted under our Congressional Protocols. These protocols provide a means of holding us accountable for commitments made to the Congress and ensuring that we are consistent in dealing with all committees and Members.

The protocols help ensure we are responsive to the committee leaders of both parties and that we efficiently use available resources to maximize our ability to meet the Congress' needs. The protocols also help us exercise the independence necessary to ensure that our products and work conform to applicable professional standards and our core values of accountability, integrity, and reliability. Additionally, the Comptroller General has regular meetings with the chairs and ranking members of congressional committees to obtain their views on GAO's work, including their priorities, and to discuss opportunities and challenges.

External advisory boards. We also rely on a range of advisory bodies to ensure we have access to a broad, external knowledge base when planning our work. We have a long track record of effectively using external advisory bodies as a governance mechanism, such as through the Comptroller General's Advisory Board, the Educators

Advisory Panel, the Executive Council on Information Management and Technology, and the Accountability Advisory Council.

More recently, we have created other specialized advisory boards of external experts, such as one for retirement security and another with experts in foresight as part of our Center for Strategic Foresight. We established the Center for Strategic Foresight to enhance our ability to identify, monitor, and analyze emerging issues and their implications for the work we do for the Congress. The Center has nine nonresident fellows, including the former head of foresight for the OECD; the former head of foresight for the World Economic Forum; and foresight experts from government, academia, the private sector, and the nonprofit sector, among others. The Center's first meeting with fellows focused on the future of privacy, and upcoming topics will include the future of space policy, automation, and genome editing.

To further enhance governance of our S&T work, we are establishing an advisory board focused on science and technology related issues. This group will consist of external S&T policy experts from industry, academia, nonprofits, and former senior government officials.
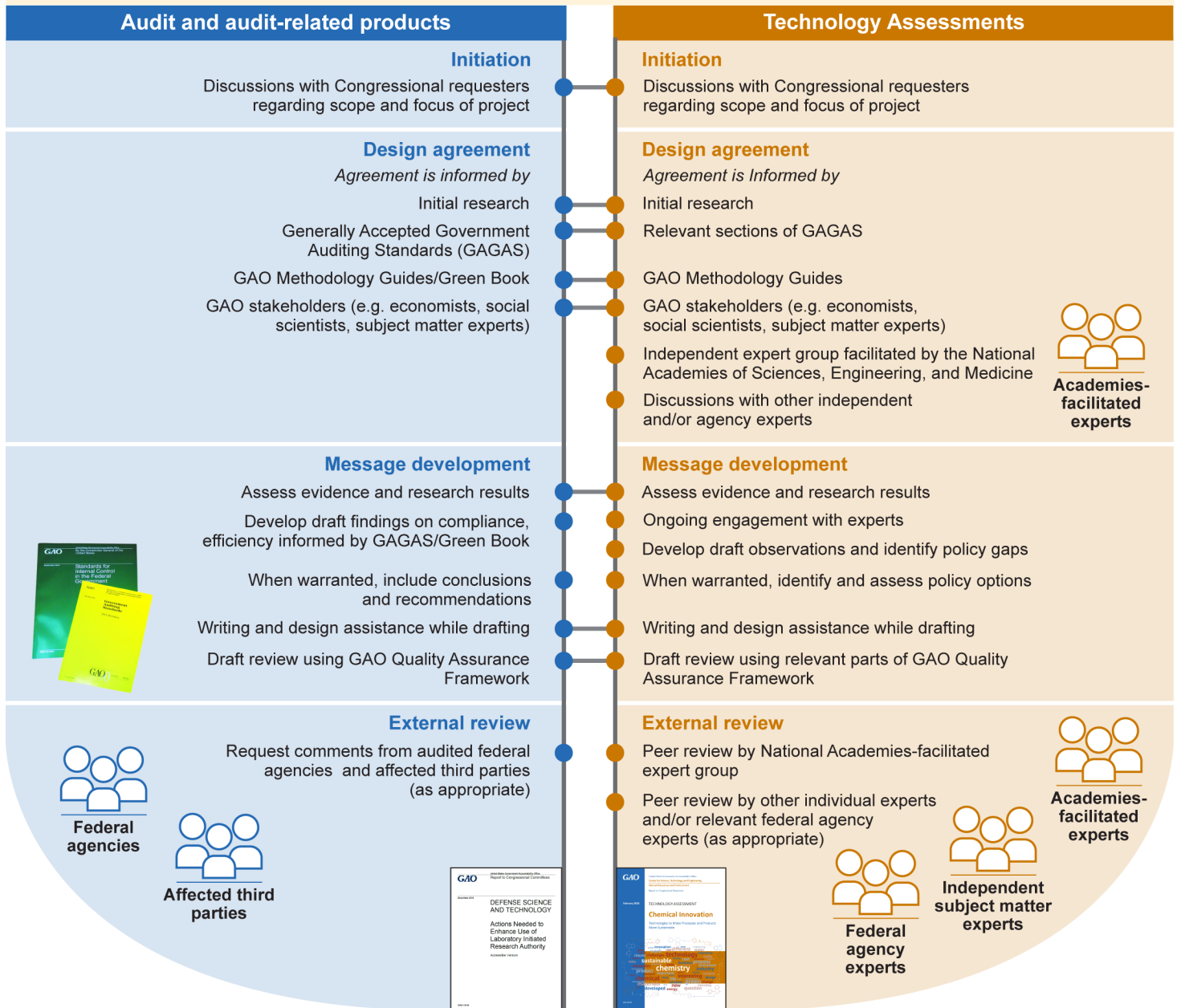
Quality assurance and peer review. Our S&T work, including technology assessments, will be governed by our existing quality assurance framework and standards that pertain to this product line. Our quality assurance framework is designed around people, processes, and technology. Our approach to quality is comprehensive and transparent. It begins with applicable professional standards and our core values, and it ends with public dissemination of nearly all GAO products. Our framework is value- and risk-based and includes an appropriate degree of transparency about key policies, procedures, criteria, and access to the results of our work. At its center is a standardized, decision-based engagement management process that provides consistency in the application of key controls. We also collaborate internally to bring the necessary range of expertise to develop each report. Finally, our quality assurance framework includes monitoring and assessment by both internal and external entities and mechanisms for continuous improvement.

Our quality assurance framework, and the institutional infrastructure supporting it, is one of our key strengths. Building on this existing framework, with respect to technology assessments, our extensive internal peer review and quality control processes are augmented by our approach for accepting requests and an external peer review process that includes multiple consultations and independent expert reviews. For example, our TAs will continue to include, as they have in the past, thorough literature reviews, information from interviews with relevant stakeholders (including agency subject matter experts and other independent experts), and information from facilitated one- or two-day meetings with subject matter experts when warranted. Throughout the message development and external review of TAs, we routinely engage with the National Academies of Sciences, Engineering, and Medicine and its array of boards and committees to leverage expertise and peer review for our TA work. As we prepare the final TA products, we leverage on-staff experts in writing, visual communication, and report quality. We also have internal experts who provide specialized knowledge in technical areas and fields such as research methods, economics, and data analytics. As such, our TAs benefit from an extensive array of both external authoritative experts and experienced policy and issue-area staff within GAO throughout the lifecycle of these reports.

However, there have been, and will continue to be, significant differences that set TAs apart from GAO's typical audit and audit-related work. These include the consultation with external experts such as the National Academies during the design of the work, the inclusion of policy options (rather than recommendations) when warranted, and a review process that emphasizes expert reviews over agency comments. Figure 8 summarizes in more detail our process for developing audit and audit-related products, and our process for developing technology assessment reports.

Figure 8: Comparison of GAO's processes for developing technology assessments and audits.

GAO's processes for developing TAs and audits are different, but they are supported by a similar quality assurance framework.

Audit and audit-related products	Technology Assessments
Initiation	**Initiation**
Discussions with Congressional requesters regarding scope and focus of project	Discussions with Congressional requesters regarding scope and focus of project
Design agreement	**Design agreement**
Agreement is informed by	*Agreement is Informed by*
Initial research	Initial research
Generally Accepted Government Auditing Standards (GAGAS)	Relevant sections of GAGAS
GAO Methodology Guides/Green Book	GAO Methodology Guides
GAO stakeholders (e.g. economists, social scientists, subject matter experts)	GAO stakeholders (e.g. economists, social scientists, subject matter experts)
	Independent expert group facilitated by the National Academies of Sciences, Engineering, and Medicine
	Discussions with other independent and/or agency experts
Message development	**Message development**
Assess evidence and research results	Assess evidence and research results
Develop draft findings on compliance, efficiency informed by GAGAS/Green Book	Ongoing engagement with experts
	Develop draft observations and identify policy gaps
When warranted, include conclusions and recommendations	When warranted, identify and assess policy options
Writing and design assistance while drafting	Writing and design assistance while drafting
Draft review using GAO Quality Assurance Framework	Draft review using relevant parts of GAO Quality Assurance Framework
External review	**External review**
Request comments from audited federal agencies and affected third parties (as appropriate)	Peer review by National Academies-facilitated expert group
	Peer review by other individual experts and/or relevant federal agency experts (as appropriate)

Academies-facilitated experts

Federal agencies

Affected third parties

Academies-facilitated experts

Independent subject matter experts

Federal agency experts

Source: GAO.

Appendix I: Selected GAO Science, Technology, Information Technology, and Cybersecurity Products, Fiscal Year 2018

Science and Technology: Considerations for Maintaining U.S. Competitiveness in Quantum Computing, Synthetic Biology, and Other Potentially Transformational Research Areas. GAO-18-656. Washington, D.C.: Sep. 26, 2018.

Biological Select Agents and Toxins: Actions Needed to Improve Management of DOD's Biosafety and Biosecurity Program. GAO-18-422. Washington, D.C.: Sep. 20, 2018.

Cybersecurity: Office of Federal Student Aid Should Take Additional Steps to Oversee Non-School Partners' Protection of Borrower Information. GAO-18-518. Washington, D.C.: Sep. 17, 2018.

Electronic Health Records: Clear Definition of the Interagency Program Office's Role in VA's New Modernization Effort Would Strengthen Accountability. GAO-18-696T. Washington, D.C.: Sep. 13, 2018.

High-Risk Series: Urgent Actions Are Needed to Address Cybersecurity Challenges Facing the Nation. GAO-18-622. Washington, D.C.: Sep. 06, 2018.

National Science Foundation: A Workforce Strategy and Evaluation of Results Could Improve Use of Rotating Scientists, Engineers, and Educators. GAO-18-533. Washington, D.C.: Sep. 05, 2018.

Data Protection: Actions Taken by Equifax and Federal Agencies in Response to the 2017 Breach. GAO-18-559. Washington, D.C.: Aug. 30, 2018.

Unmanned Aircraft: The Navy Has Reduced MQ-25 Development Risk, but Should Improve Its Cost Estimate. GAO-18-541SU. Washington, D.C.: Aug. 09, 2018.

Critical Infrastructure Protection: DHS Should Take Actions to Measure Reduction in Chemical Facility Vulnerability and Share Information with First Responders. GAO-18-538. Washington, D.C.: Aug. 08, 2018.

Military Space Systems: DOD's Use of Commercial Satellites to Host Defense Payloads Would Benefit from Centralizing Data. GAO-18-493. Washington, D.C.: July 30, 2018.

National Institute of Standards and Technology: Additional Review and Coordination Could Help Meet Measurement Service Needs and Strengthen Standards Activities. GAO-18-445. Washington, D.C.: July 26, 2018.

DNA Evidence: Preliminary Observations on DOJ's DNA Capacity and Backlog Reduction Grant Program. GAO-18-651T. Washington, D.C.: July 18, 2018.

Information Security: Supply Chain Risks Affecting Federal Agencies. GAO-18-667T. Washington, D.C.: July 12, 2018.

NASA Commercial Crew Program: Plan Needed to Ensure Uninterrupted Access to the International Space Station. GAO-18-476. Washington, D.C.: July 11, 2018.

Artificial Intelligence: Emerging Opportunities, Challenges, and Implications for Policy and Research. GAO-18-644T. Washington, D.C.: June 26, 2018.

Identity Theft: IRS Needs to Strengthen Taxpayer Authentication Efforts. GAO-18-418. Washington, D.C.: June 22, 2018.

Information Security: CDC Needs to Improve Its Program and Resolve Critical Control Deficiencies. GAO-18-437SU. Washington, D.C.: June 20, 2018.

Federal Research: Additional Actions Needed to Improve Licensing of Patented Laboratory Inventions. GAO-18-327. Washington, D.C.: June 19, 2018.

Cybersecurity Workforce: Agencies Need to Improve Baseline Assessments and Procedures for Coding Positions. GAO-18-466. Washington, D.C.: June 14, 2018.

NASA Major Projects: Portfolio Is At Risk for Continued Cost Growth and Schedule Delays. GAO-18-576T. Washington, D.C.: June 14, 2018.

F-35 Joint Strike Fighter: Development Is Nearly Complete, but Deficiencies Found in Testing Need to Be Resolved. GAO-18-321. Washington, D.C.: June 05, 2018.

National Science Foundation: Revised Policies on Developing Costs and Schedules Could Improve Estimates for Large Facilities. GAO-18-370. Washington, D.C.: June 01, 2018.

B61-12 Nuclear Bomb: Cost Estimate for Life Extension Incorporated Best Practices, and Steps Being Taken to Manage Remaining Program Risks. GAO-18-456. Washington, D.C.: May 31, 2018.

Small Unmanned Aircraft Systems: FAA Should Improve Its Management of Safety Risks. GAO-18-110. Washington, D.C.: May 24, 2018.

Energy Storage: Information on Challenges to Deployment for Electricity Grid Operations and Efforts to Address Them. GAO-18-402. Washington, D.C.: May 24, 2018.

NASA Information Technology: Urgent Action Needed to Address Significant Management and Cybersecurity Weaknesses. GAO-18-337. Washington, D.C.: May 22, 2018.

Cybersecurity: DHS Needs to Enhance Efforts to Improve and Promote the Security of Federal and Private-Sector Networks. GAO-18-520T. Washington, D.C.: Apr. 24, 2018.

Climate Change Adaptation: DOD Needs to Better Incorporate Adaptation into Planning and Collaboration At Overseas Installations. GAO-18-265C. Washington, D.C.: Apr. 02, 2018.

Illicit Opioids: While Greater Attention Given to Synthetic Opioids, Agencies Need to Better Assess Their Efforts. GAO-18-205. Washington, D.C.: Mar. 29, 2018.

Artificial Intelligence: Emerging Opportunities, Challenges, and Implications. GAO-18-142SP. Washington, D.C.: Mar. 28, 2018.

Science, Technology, Engineering, and Mathematics Education: Actions Needed to Better Assess the Federal Investment. GAO-18-290. Washington, D.C.: Mar. 23, 2018.

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Financial Technology: Additional Steps by Regulators Could Better Protect Consumers and Aid Regulatory Oversight. GAO-18-254. Washington, D.C.: Mar. 22, 2018.

U.S. Patent and Trademark Office: Observations on the Covered Business Method Patent Review Program. GAO-18-451T. Washington, D.C.: Mar. 20, 2018.

Food Safety: USDA Should Take Further Action to Reduce Pathogens in Meat and Poultry Products. GAO-18-272. Washington, D.C.: Mar. 19, 2018.

Food Safety: Federal Efforts to Manage the Risk of Arsenic in Rice. GAO-18-199. Washington, D.C.: Mar. 16, 2018.

Electronic Health Information: CMS Oversight of Medicare Beneficiary Data Security Needs Improvement. GAO-18-210. Washington, D.C.: Mar. 06, 2018.

Nuclear Weapons: NNSA Should Clarify Long-Term Uranium Enrichment Mission Needs and Improve Technology Cost Estimates. GAO-18-126. Washington, D.C.: Feb. 16, 2018.

Critical Infrastructure Protection: Additional Actions Are Essential for Assessing Cybersecurity Framework Adoption. GAO-18-211. Washington, D.C.: Feb. 15, 2018.

Chemical Innovation: Technologies to Make Processes and Products More Sustainable. GAO-18-307. Washington, D.C.: Feb. 08, 2018.

Critical Infrastructure Protection: Electricity Suppliers Have Taken Actions to Address Electromagnetic Risks, and Additional Research Is Ongoing. GAO-18-67. Washington, D.C.: Feb. 07, 2018.

Cybersecurity Workforce: Urgent Need for DHS to Take Actions to Identify Its Position and Critical Skill Requirements. GAO-18-175. Washington, D.C.: Feb. 06, 2018.

Small Business Research Programs: Agencies Need to Take Steps to Assess Progress Toward Commercializing Technologies. GAO-18-207. Washington, D.C.: Jan. 31, 2018.

Homeland Defense: Urgent Need for DOD and FAA to Address Risks and Improve Planning for Technology That Tracks Military Aircraft. GAO-18-177. Washington, D.C.: Jan. 18, 2018.

Nuclear Security: CBP Needs to Take Action to Ensure Imported Radiological Material Is Properly Licensed. GAO-18-214. Washington, D.C.: Jan. 10, 2018.

Columbia Class Submarine: Immature Technologies Present Risks to Achieving Cost, Schedule, and Performance Goals. GAO-18-158. Washington, D.C.: Dec. 21, 2017.

Generic Drugs: FDA Should Make Public Its Plans to Issue and Revise Guidance on Nonbiological Complex Drugs. GAO-18-80. Washington, D.C.: Dec. 14, 2017.

Telecommunications: FCC Should Improve Monitoring of Industry Efforts to Strengthen Wireless Network Resiliency. GAO-18-198. Washington, D.C.: Dec. 12, 2017.

Internet of Things: FCC Should Track Growth to Ensure Sufficient Spectrum Remains Available. GAO-18-71. Washington, D.C.: Nov. 16, 2017.

Plutonium Disposition: Observations on DOE and Army Corps Assessments of the Mixed Oxide Fuel Fabrication Facility Contract. GAO-18-122R. Washington, D.C.: Nov. 15, 2017.

Low-Dose Radiation: Interagency Collaboration on Planning Research Could Improve Information on Health Effects. GAO-18-184T. Washington, D.C.: Nov. 01, 2017.

Defense Microelectronics: Efforts Ongoing to Increase Trusted Sources, But a National Strategy Is Needed to Strengthen the Industrial Base. GAO-18-43SU. Washington, D.C.: Oct. 26, 2017.

Contingent Workforce: Size, Characteristics, Compensation, and Work Experiences of Adjunct and Other Non-Tenure-Track Faculty. GAO-18-49. Washington, D.C.: Oct. 19, 2017.

High-Containment Laboratories: Coordinated Actions Needed to Enhance the Select Agent Program's Oversight of Hazardous Pathogens. GAO-18-145. Washington, D.C.: Oct. 19, 2017.

Water Pollution: Some States Have Trading Programs to Help Address Nutrient Pollution, but Use Has Been Limited. GAO-18-84. Washington, D.C.: Oct. 16, 2017.

FIRSTNET: Efforts to Establish the Public Safety Broadband Network. GAO-18-187T. Washington, D.C.: Oct. 12, 2017.

Biodefense: Federal Efforts to Develop Biological Threat Awareness. GAO-18-155. Washington, D.C.: Oct. 11, 2017.

Appendix II: Consultations with External Stakeholders, as of March 15, 2019[6]

Consultations with Members of Congress and/or Congressional Staff

U.S. Senate

Armed Services Committee

Commerce, Science, and Transportation Committee

Finance Committee

Homeland Security and Governmental Affairs Committee

Legislative Branch Subcommittee, Committee on Appropriations

Small Business and Entrepreneurship Committee

House of Representatives

Education and Labor Committee (previously the Education and Workforce Committee)

Energy and Commerce Committee

Legislative Branch Subcommittee, Committee on Appropriations

Modernization of Congress Select Committee

Oversight and Reform Committee (previously the Oversight and Government Reform Committee)

Science, Space, and Technology Committee

Small Business Committee

Veterans' Affairs Committee

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[6]Additional consultations will continue throughout fiscal year 2019.

Academic Institutions

Arizona State University, Consortium for Science, Policy & Outcomes

Carnegie Mellon University

Georgia Institute of Technology

Harvard Kennedy School's Belfer Center for Science and International Affairs

Massachusetts Institute of Technology

Other External Stakeholders

American Association for the Advancement of Science (AAAS)

American Chemical Society (ACS)

IBM Center for the Business of Government

Institute for Defense Analyses (IDA)

Institute of Electrical and Electronics Engineers (IEEE)

Lincoln Network

National Academies of Sciences, Engineering, and Medicine (NASEM)

The Mitre Corporation

Appendix III: Methodology

In the process of establishing the STAA team, as of March 15, 2019, we have conducted more than 30 meetings and workshops with Members of Congress and congressional staff; academic institutions with a nexus of science, engineering, and public policy; and other organizations that analyze policy or study science, technology, national security and competitiveness. Going forward, we plan to remain engaged with Members of Congress, congressional staff, as well as the broader national and global scientific community, and to continue seeking these stakeholders' input.

From Members of Congress and congressional staff, we sought input on their priorities as they related to S&T issues, and on the types of services that would be most helpful (e.g., reports, technology assessments, and rapid technical assistance).

From external stakeholders, we sought input on ways to incorporate policy options into technology assessments, which we identified as a congressional need. We met with representatives from academic institutions;[7] federally funded research and development centers; the National Academies of Sciences, Engineering, and Medicine; professional scientific societies, including the American Association for the Advancement of Science, the American Chemical Society, and the Institute of Electrical and Electronics Engineers; and others. See appendix II for a full list of congressional and other external stakeholders we contacted.

From internal stakeholders we sought input on the new team's organizational structure and staffing levels, plans for reassigning current GAO staff and hiring new staff, and timelines. This helped us stand up the new team efficiently while ensuring a seamless continuation of ongoing S&T work. We met the management of other GAO mission teams and GAO bargaining unit and non-bargaining unit employees, among others.

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[7]These institutions focus on the intersection of science, technology, and policy. They include the Consortium for Science, Policy & Outcomes at Arizona State University; Carnegie Mellon University; the Georgia Institute of Technology; Harvard Kennedy School's Belfer Center for Science and International Affairs; and the Massachusetts Institute of Technology.

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