



July 2022

# SMALL BUSINESS RESEARCH PROGRAMS

## Air Force Had Success in Some Areas with New Awards Process

Accessible Version

# GAO Highlight

Highlights of [GAO-22-105223](#), a report to congressional committees

## Why GAO Did This Study

Air Force is among the largest federal funders of SBIR and STTR awards to small businesses. It issued over 4,800 such awards in fiscal years 2016 through 2020 to support companies' technology commercialization and provide technology solutions to meet Air Force's needs. Since 2018, Air Force has rapidly expanded the new open topics SBIR/STTR awards process.

The House committee report accompanying the National Defense Authorization Act for Fiscal Year 2021 includes provisions for GAO to review the new process. This report examines (1) how Air Force implemented its new awards process and (2) what is known about the process's effectiveness—as compared to Air Force's conventional SBIR/STTR awards process—in attracting a broad range of companies; reducing award issuance times; and enabling commercialization through subsequent venture capital investment or non-SBIR/STTR federal contracts.

GAO analyzed Air Force SBIR and STTR award data from fiscal years 2016 through 2020 and documents, including evaluations of the new process. GAO also analyzed contract files for a non-generalizable sample of 17 awards, and interviewed Air Force and DOD officials and awardees.

## What GAO Recommends

GAO is making two recommendations to improve Air Force's reporting and data reliability on certain small business participation. DOD agreed with the first recommendation and partially agreed with the second, as discussed in the report.

View [GAO-22-105223](#). For more information, contact Candice Wright at (202) 512-6888 or [WrightC@gao.gov](mailto:WrightC@gao.gov)

July 2022

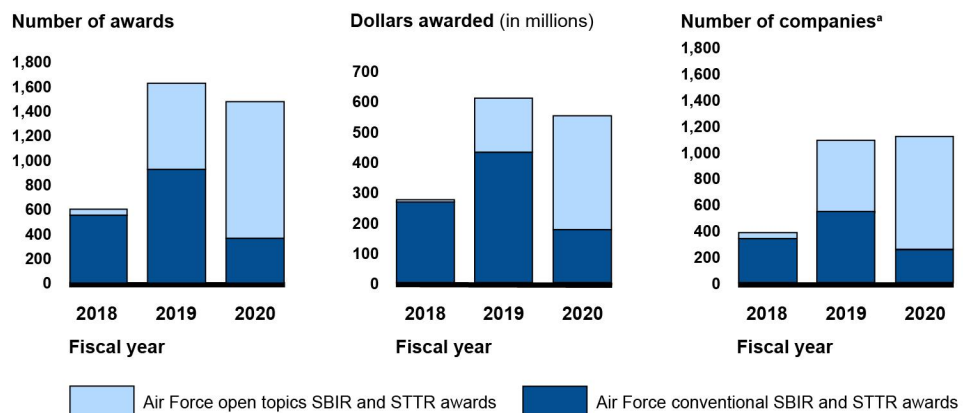
# SMALL BUSINESS RESEARCH PROGRAMS

## Air Force Had Success in Some Areas with New Awards Process

### What GAO Found

In June 2018, Air Force implemented a new “open topics” process for issuing Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) awards to attract new small businesses and deliver technology solutions faster to the Air Force. The new process gives companies more latitude to propose technology solutions to meet Air Force's needs. Expansion of the new process coincided with an overall increase in Air Force's SBIR/STTR effort. By the end of fiscal year 2020, the new process had largely displaced the agency's conventional awards process, in which specific problems and mission needs were identified by Air Force (see figure).

**Number of SBIR or STTR Awards, Dollars Awarded, and Number of Companies that Received Awards under Air Force's Open Topics or Conventional SBIR/STTR Awards Process, Fiscal Years 2018 through 2020**



Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) awards data. | [GAO-22-105223](#)

### Accessible Data Table for Highlight Figure

	Fiscal Year	Number of Awards	Dollars Awarded (in millions)	Number of companies
Air Force conventional SBIR and STTR awards	2018	553	\$271.24	346
Air Force conventional SBIR and STTR awards	2019	925	\$432.2	560
Air Force conventional SBIR and STTR awards	2020	358	\$176.4	259
Air Force open topics SBIR and STTR awards	2018	50	\$2.47	48
Air Force open topics SBIR and STTR awards	2019	704	\$171.13	569
Air Force open topics SBIR and STTR awards	2020	1,107	\$381.07	887

<sup>a</sup>Companies that received both open topics and conventional awards in fiscal years 2018 through 2020 are included more than once in the bar graph showing the number of companies.

Air Force's new process was more effective than its conventional SBIR/STTR awards process in attracting new companies and issuing awards quickly. According to GAO's analysis of Air Force SBIR/STTR award data and federal contracting data, around 43 percent of the 1,001 open topics awardees had no prior federal contracts, compared to 14 percent of the 771 conventional awardees. Also, Air Force took between 108 and 126 fewer days, on average, to issue open topics awards in fiscal years 2019 and 2020 for the first SBIR/STTR program phase. An April 2021 study found that open topics awardees were more likely to obtain subsequent venture capital or non-SBIR/STTR contracts.

Data and assessment gaps, however, limit Air Force's ability to evaluate the effectiveness of the new process. Its 2021 impact report did not address whether participation among women-owned small businesses increased, as called for in the committee report. Also, Air Force did not ensure the report's data on participation by disadvantaged businesses and company size was current and reliable. Ensuring data in such reports are current and reliable would aid Air Force in assessing the reach and effectiveness of the open topics process.

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**Abbreviations**

AFRL	Air Force Research Laboratory
DOD	Department of Defense
FPDS-NG	Federal Procurement Data System–Next Generation
FY	fiscal year
HUBZone	historically underutilized business zone
OUSD R&E	Office of the Under Secretary of Defense for Research and Engineering
R&D	research and development
SAM	System for Award Management
SBA	Small Business Administration
SBIR	Small Business Innovation Research
STRATFI	Strategic Funding Increase
STTR	Small Business Technology Transfer
TACFI	Tactical Funding Increase
TRL	technology readiness level

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July 21, 2022

Congressional Committees

Congress established the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs to enable federal agencies to support research and development (R&D) projects conducted by small businesses.<sup>1</sup> The goals of these programs are to stimulate the national economy through innovation, technology transfer, and commercialization; use small businesses to meet federal R&D needs; and foster participation by women-owned and socially and economically disadvantaged small businesses in technology innovation.<sup>2</sup> Both programs require federal agencies to expend a portion of their overall R&D budget on awards to small businesses. Specifically, agencies with an extramural budget for research or R&D in excess of \$100 million must participate in the SBIR program. Agencies with such obligations of \$1 billion or more, such as Air Force, must also participate in the STTR program.<sup>3</sup>

Air Force is among the largest funders of SBIR and STTR awards among participating agencies across the federal government. From fiscal years (FY) 2016 through 2020, Air Force’s budget for SBIR/STTR awards

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<sup>1</sup>The Small Business Innovation Development Act of 1982 established the SBIR program. Pub. L. No. 97-219, 96 Stat. 217 (1982). This act amended section 9 of the Small Business Act, Pub. L. No. 85-536, 72 Stat. 384 (1958), codified as amended at 15 U.S.C. § 638. The Small Business Technology Transfer Act of 1992 established the STTR program. Pub. L. No. 102-564, tit. II, 106 Stat. 4249, 4256 (1992). This act made additional amendments to section 9 of the Small Business Act.

<sup>2</sup>The SBIR and STTR programs are similar in that participating agencies identify topics for R&D projects and make awards to qualified small businesses. The STTR program also requires the small business awardees to partner with a not-for-profit research institution, such as a university or a federally funded research and development center. Both programs are carried out in accordance with statutory and regulatory requirements and under oversight and guidance of the Small Business Administration (SBA). See 15 U.S.C. § 638.

<sup>3</sup>15 U.S.C. §§ 638(f)(1), (n)(1)(A). Agencies’ R&D programs generally include funding for two types of R&D: intramural and extramural. Intramural R&D is conducted by employees of a federal agency in or through government-owned, government-operated facilities. Extramural R&D is generally conducted by nonfederal entities and personnel outside of federal facilities.

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totaled over \$3 billion. During that time, the agency issued over 4,800 awards, according to our analysis.

In June 2018, Air Force implemented a new “open topics” awards process for many of its SBIR and STTR awards. Air Force adopted the new process to better leverage technologies initially developed for the private sector, deliver faster technology solutions to Air Force programs and the warfighter, and attract new businesses to Air Force and Department of Defense (DOD). Under the open topics process, Air Force no longer defines specific problems and mission needs for small businesses to address. Instead, the businesses themselves define both the problems and the potential R&D or technology solutions they can provide to address Air Force needs.<sup>4</sup> Air Force operates this new process in tandem with its longstanding conventional SBIR/STTR awards process.

The committee report accompanying the National Defense Authorization Act for Fiscal Year 2021 includes provisions for GAO to review Air Force’s open topics process, including comparisons to Air Force’s conventional awards process.<sup>5</sup> This report examines (1) how Air Force implemented the open topics process for its SBIR/STTR awards and (2) what is known about the effectiveness of the open topics process, as compared to Air Force’s conventional SBIR/STTR process, in expanding SBIR/STTR access to a broader range of companies, reducing award processing times, and commercializing technologies.

To address these objectives, we analyzed Air Force’s SBIR/STTR award data from prior GAO studies for trends in the number and dollar value of open topics and conventional SBIR/STTR awards, award timeframes, company diversity, and other attributes. We evaluated conventional SBIR/STTR awards from FY 2016 through 2020 and open topics awards from FY 2018 through 2020—the most recent data available. We merged these data with selected data elements from SBA’s SBIR/STTR award data available at SBIR.gov and the Federal Procurement Data System—

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<sup>4</sup>While open topics solicitations may suggest certain technology areas, such as sensors or artificial intelligence, the solicitations also state that the topics are open to any industry, technology, and problem area. The solicitations further state that Air Force intends to explore technology solutions with demonstrated commercial value that can be adapted to meet defense needs in a short timeframe and at a low cost. As noted elsewhere in this report, outside of SBIR/STTR solicitations, Air Force also maintains an online list of focus areas, or problems needing a technical solution.

<sup>5</sup>H. Rpt. 116-442 of the Committee on Armed Services, which accompanies the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283 (Jan. 1, 2021).



Next Generation (FPDS-NG). Because our analyses used data from different sources, results of our analyses may differ from other published sources.

We also examined contract files for a random, non-generalizable selection of 17 Air Force open topics and conventional SBIR/STTR contracts awarded in FY 2019 and 2020. We interviewed company representatives from 12 of the 17 awardees about their experiences with the awards process. In addition, we examined two published evaluations of the effectiveness of the open topics process; reviewed documentation of Air Force's awards process; and interviewed Air Force and other DOD SBIR/STTR officials. See appendix I for additional information on our objectives, scope, and methodology.

We conducted this performance audit from May 2021 to July 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## Background

Agencies participating in the SBIR/STTR programs solicit proposals from small businesses in one or more annual award cycles. The solicitations remain open for a specified period in which the agencies accept proposals. The agencies then evaluate proposals after the solicitation's close date for possible award.

DOD issues SBIR or STTR solicitations during three annual award cycles, inviting small businesses to propose R&D or technology solutions to problems or mission needs defined by DOD or its components. The problems or mission needs are expressed in topics, which DOD or its components, including Air Force, provide and are published with the solicitations. Under Air Force's conventional SBIR/STTR process, topics have typically been identified by researchers and technical experts in the Air Force Research Laboratory (AFRL) or other Air Force organizations, according to Air Force officials. AFRL conducts R&D at Air Force facilities to support the agency's programs, missions, and capabilities worldwide. Under the open topics process, the small businesses, rather than Air

Force, propose both the potential needs and the technology solutions to address those needs.

Under the SBIR/STTR awards process, participating agencies issue awards to small businesses for three phases of technology development:

- **Phase I: Feasibility.** Small businesses conduct R&D activities to determine the scientific and technical merit and feasibility of ideas that may have commercial potential. As of November 2021, under conventional SBIR/STTR, agencies may generally issue Phase I awards of up to \$275,766 (including any modifications of the initial award amount) and 6 months for SBIR or 12 months for STTR awards. Companies compete for these awards in response to SBIR or STTR solicitations issued by the agencies. With Air Force, companies submit proposals through DOD's online application portal. Proposals are then screened for compliance with application requirements. After the solicitation close date, Air Force evaluators review and score qualified proposals on factors such as technical merit and commercial potential. Generally, companies are notified of the selection decisions, and companies selected for an award are issued a contract.<sup>6</sup> The number of awards in an awards cycle depends on the funding available and programmatic need.
- **Phase II: Prototyping.** Phase I awardees with projects that demonstrate scientific and technical merit, as well as commercial potential, may compete for a Phase II award to continue the R&D. Those activities could include developing a prototype; making other advancements, such as operational testing of the mature technology; or, in Air Force, delivering the completed technology to an "end-user." (An end-user is a program or organization that would use the technology.) Agencies generally issue conventional Phase II awards of up to \$1,836,463 (including modifications) and 24 months.<sup>7</sup> Under Air Force's conventional SBIR/STTR process, Air Force invites Phase

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<sup>6</sup>Air Force issues its SBIR/STTR funding agreement awards as contracts. Other agencies may use contracts, grants, or cooperative agreements.

<sup>7</sup>DOD and other agencies are also authorized to issue Direct-to-Phase II awards to small businesses that did not receive a Phase I award but completed equivalent work using non-SBIR/STTR funds.

Maximum award amounts for Phase I and Phase II are as of November 2021 and may include award modifications. Agencies can seek approval from SBA to award a company Phase I or Phase II funding beyond the aforementioned maximum.

I awardees to submit Phase II proposals in response to a SBIR or STTR solicitation.

- **Phase III: Commercialization.** These are non-SBIR/STTR awards for further R&D, testing, or the purchase of mature technologies developed under Phases I and II. These awards can include Phase III prime contracts awarded by federal agencies or subcontracts from other federal contractors or subcontractors, which may be awarded without further competition. Phase III awards can also include funding from nonfederal sources, such as private investment from venture capital firms; royalties from patents; or other commercialization achievements stemming from SBIR/STTR funded technologies. Unlike Phase I and II awards, Phase III awards are not funded from agencies' SBIR/STTR budgets, and SBA's SBIR/STTR policies place no limit on the number, duration, type, or dollar value of Phase III awards.<sup>8</sup>

SBIR and STTR awards under the open topics process generally follow the same basic steps as the conventional process, though there are several differences. Specifically:

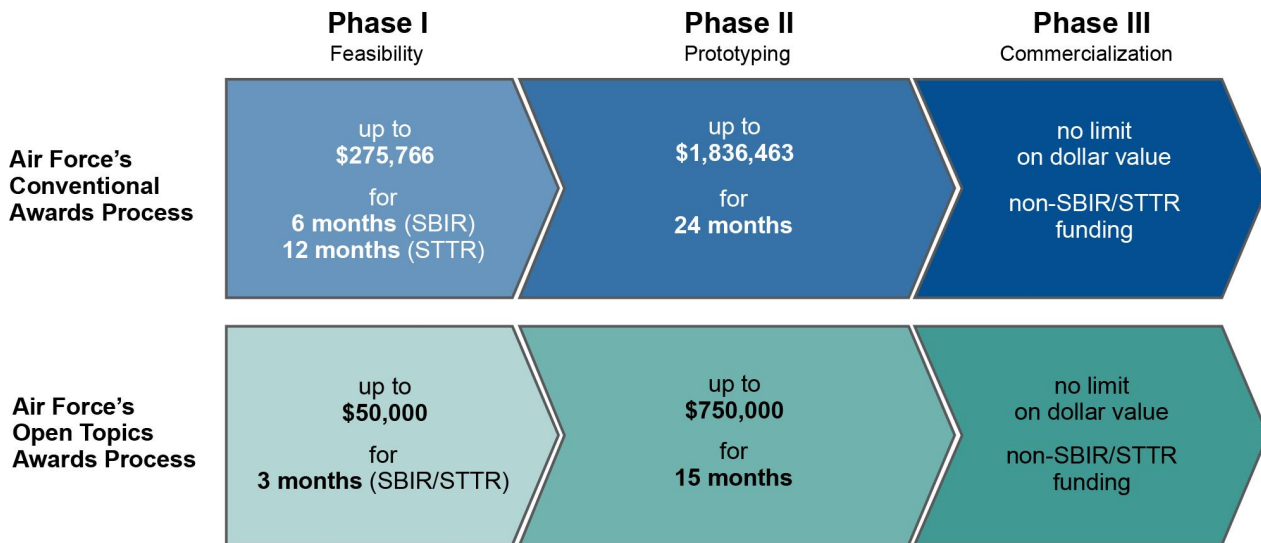
- Compared to conventional SBIR/STTR awards, the period of performance for open topics Phase I awards is shorter (up to 3 months), and the maximum dollar value smaller (up to \$50,000). For open topics Phase II awards, the period of performance and maximum dollar value are also smaller—up to 15 months and \$750,000 for open topics compared to up to 24 months and over \$1.8 million for conventional awards. However, award extensions and supplemental Phase II awards are also possible for both open topics and conventional Phase II awardees (see fig. 1).<sup>9</sup>

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<sup>8</sup>SBA, *Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Policy Directive*. (Oct. 1, 2020).

<sup>9</sup>In a solicitation which closed in February 2022, Air Force increased the maximum dollar amount to \$1.25 million for open topics Phase II awards. In a solicitation which will close in September 2022, Air Force increased the maximum dollar amount to \$75,000 for open topics Phase I awards.

**Figure 1: Air Force’s Conventional and Open Topics Small Business Awards Processes**



Source: GAO analysis of Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) program information from Air Force and the Small Business Administration. | GAO-22-105223

Note: Conventional award amount limits are adjusted each year for inflation. In fiscal year 2022, Air Force increased the maximum amount for open topics Phase II awards to \$1.25 million and will increase the maximum for Phase I open topics to \$75,000.

- Open topics awardees spend Phase I analyzing the feasibility of their concept within Air Force. This includes first identifying potential end-users and others in Air Force to verify the “market” for their proposed technology. The Phase I awardees may also conduct R&D to further develop the technology, for example, to begin customizing it to specifications or capabilities expressed by end-users. Air Force officials told us this differs from conventional awards, in which Air Force may have already identified organizations, such as an end-

Air Force encourages open topics Phase II awardees to obtain up to \$1.5 million of matching funds. Additionally, Air Force may award companies a supplemental Phase II award through one of its new AFWERX programs, Strategic Funding Increase (STRATFI) and Tactical Funding Increase (TACFI). These programs allow recent Phase II awardees to receive supplemental funding to help them further develop their technology for commercialization. Companies with an active or recent open topics or conventional Phase II award can submit proposals for these awards in response to a notice of opportunity. Under both programs, companies must obtain non-SBIR/STTR matching funds from a federal or non-federal source, such as an end-user of the technology or a private investor. Under STRATFI, companies may receive from Air Force supplemental awards between \$3 million and \$15 million, but the companies must also obtain both federal and nonfederal matching funds, according to Air Force. Under TACFI, companies may receive from Air Force supplemental awards between \$375,000 and \$1.8 million, in addition to matching funds from either source. Award durations and matching requirements differ for the two programs.

user, with specific technology needs to which conventional awardees are responding.

- After Phase I, to be considered for an open topics Phase II award, companies must submit a support memorandum with their Phase II application from a potential end-user, such as an Air Force squadron. The memorandum verifies the mission need and expresses support for the proposed technology's continued R&D. A support memorandum must also identify and include the signature of Air Force or DOD purchasers who can authorize or facilitate the future purchase of the mature technology for end-users. The memorandum is not required under the conventional process. Under either process, companies may be eligible for a direct-to-Phase-II award from Air Force without participating in Phase I; companies applying for a direct-to-Phase-II award under the open topics process must include a support memorandum with their proposal.

The open topics awards process is administered by AFVentures, one of three organizations within Air Force's technology accelerator, known as AFWERX. According to Air Force officials, AFVentures staff coordinate and manage the solicitation, proposal evaluation, and issuance of open topics awards. Technical points of contact and others in AFVentures help administer the contracts for the open topics awards. Air Force reorganized AFWERX under AFRL in 2020.

According to Air Force officials, since the open topics process was established in June 2018, two main evaluations of the new process's effectiveness have been issued. In early 2021, Air Force issued the *AFVentures FY18-20 Impact Report*—Air Force's first and, so far, only such report on the open topics process.<sup>10</sup> The other evaluation is a study coauthored by the former AFVentures director and outside researchers issued in April 2021 on the website of the National Bureau of Economic Research.<sup>11</sup> The study's authors used an econometric model to examine the effectiveness of Air Force's open topics and conventional awards processes in 2017 through 2019 in attracting new and diverse companies to Air Force's SBIR/STTR program and DOD and in helping SBIR/STTR awardees commercialize technologies.

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<sup>10</sup>Air Force, *AFVentures FY18-20 Impact Report*. (2021).

<sup>11</sup>Sabrina T. Howell, Jason Rathje, John Van Reenen and Jun Wong, *Opening up Military Innovation: Causal Effects of 'Bottom-Up' Reforms to U.S. Defense Research*, National Bureau of Economic Research (NBER) Working Paper No. 28700 (pre-publication draft, Nov. 26, 2020; published, Apr. 2021; updated Aug. 2021).

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## Air Force Rapidly Expanded the Open Topics Process and Took Measures to Manage a Sometimes Difficult Implementation

Air Force expanded the open topics process rapidly, requiring new measures to manage an associated influx of SBIR/STTR proposals, awards, and companies. From June 2018, when the open topics process began, through the end of September 2020, the number of open topics awards, proposals, and companies grew rapidly. Air Force implemented various measures to manage this influx, including creating events and online resources, among other measures. At the same time, the rapid expansion contributed to a sometimes difficult implementation, mainly in FY 2019 and 2020. We identified implementation challenges from our prior work, Air Force documents, and interviews with company representatives from our non-generalizable sample of SBIR and STTR awards.

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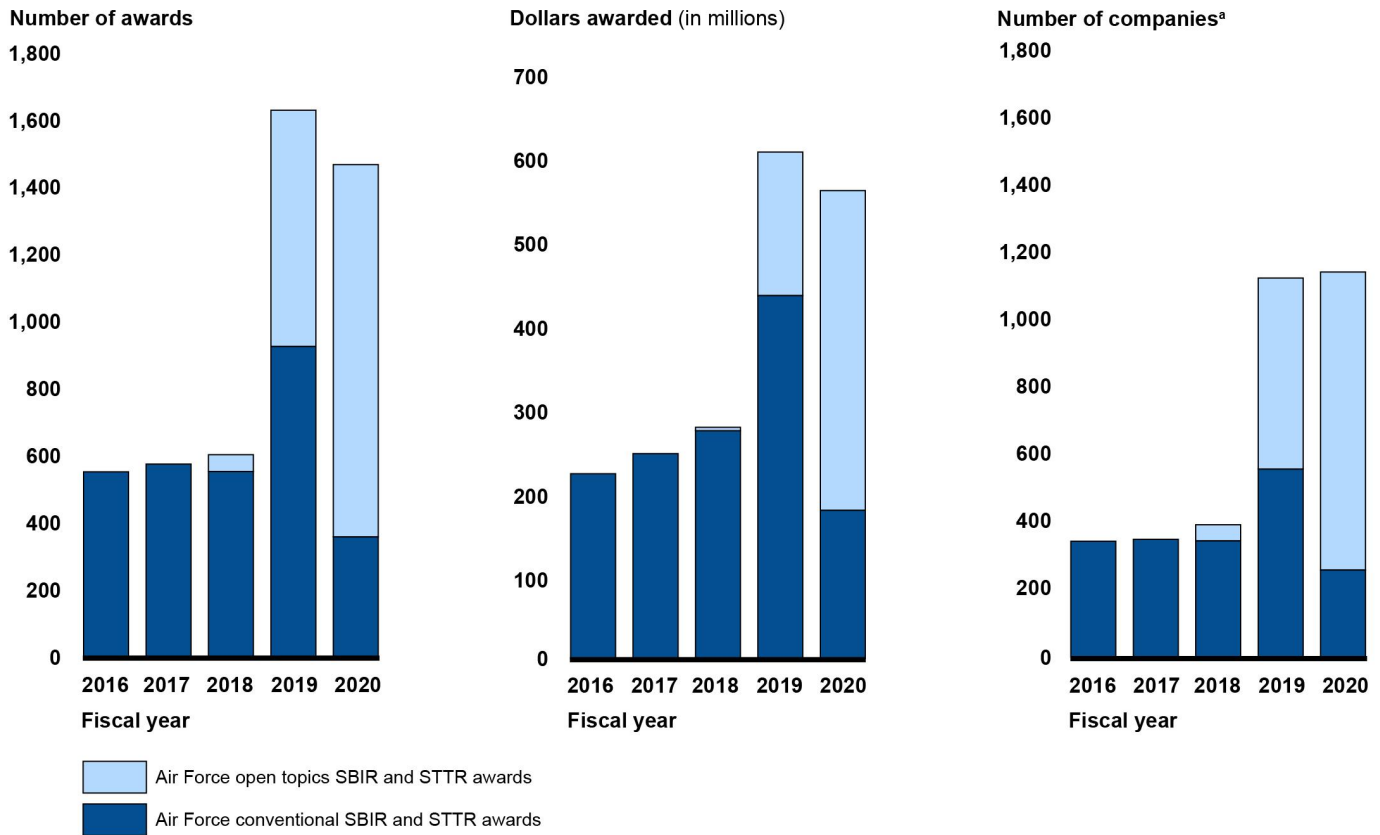
### Air Force Rapidly Expanded Its Open Topics Process in Fiscal Years 2018 through 2020

Air Force started the new process in FY 2018 as a trial run with 50 open topics Phase I awards in FY 2018 (but no Phase II awards) totaling \$2.5 million, according to our analysis of data. According to a letter from the Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics, Air Force was encouraged by small business interest in the trial run and non-SBIR funding received by participants.<sup>12</sup> In FY 2019, Air Force quickly expanded its new process to 704 open topics Phase I and Phase II awards totaling \$171 million—a 14-fold increase in the number of awards and a 69-fold increase in the dollar value of awards. The rapid expansion continued in FY 2020 to 1,107 open topics awards totaling over \$380 million, largely displacing Air Force’s conventional awards by the end of that year. Also during this time, the number of companies receiving Air Force SBIR/STTR awards increased substantially (see fig. 2).

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<sup>12</sup>Letter to the Honorable Lori Trahan, United States House of Representatives, from William B. Roper, Jr., Assistant Secretary of the Air Force (Acquisition, Technology, and Logistics), June 9, 2020.

**Figure 2: Number of Awards, Dollars Awarded, and Number of Companies that Received Awards under Air Force’s Open Topics and Conventional SBIR/STTR Processes, Fiscal Years 2016 through 2020**



Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) awards data. | GAO-22-105223

**Accessible Data Table for Figure 2**

	Fiscal Year	Number of awards	Dollars awarded (in millions)	Number of companies
Air Force conventional SBIR and STTR awards	2016	552	\$220.01	345
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Air Force open topics SBIR and STTR awards	2020	1,107	\$381.07	887

<sup>a</sup>Companies that received both open topics and conventional awards in fiscal years 2016 through 2020 are included more than once in the chart on number of companies.

The number of SBIR/STTR proposals Air Force received from companies also rapidly increased from FY 2018 through FY 2020. This coincided with an increase in Air Force’s SBIR/STTR budget, which more than doubled, from over \$330 million in FY 2016 to over \$880 million in FY 2020. According to Air Force officials, Air Force responded by increasing the number of annual SBIR/STTR award cycles from one to three.

Air Force officials attributed the increase in proposals to the popularity of the open topics process. According to data from the Office of the Under Secretary of Defense for Research and Engineering (OUSD R&E), the number of open topics proposals increased eight-fold, from 575 in FY 2018 to over 4,700 in FY 2020. By the end of FY 2020, open topics proposals had largely displaced those for conventional awards, which declined after FY 2018 (see table 1).



**Table 1: Number of Small Business Proposals Submitted to Air Force for Open Topics and Conventional Awards, Fiscal Years 2016 through 2020**

	Open Topics	Conventional	Total
2016	n/a	2,594	<b>2,594</b>
2017	n/a	2,642	<b>2,642</b>
2018	575	4,009	<b>4,584</b>
2019	1,648	3,701	<b>5,349</b>
2020	4,720	1,097	<b>5,817</b>

Source: GAO analysis of DOD data. | GAO-22-105223

Representatives of many of the companies in our non-generalizable sample of awards said that the open topics approach greatly influenced their decision to apply for an Air Force SBIR or STTR award or made other positive comments about the new process.<sup>13</sup> Officials from one company said the broad nature of the topics made it possible for them to participate in Air Force SBIR/STTR, rather than waiting for an appropriate conventional topic. Representatives of other companies said open topics provided a way to enter the DOD market or enhance their company’s product, while another company’s representatives said that open topics provided the company more flexibility to define a problem needing a technical solution.

### Air Force Implemented Various Measures to Manage Influx of SBIR/STTR Proposals, Awards, and Companies

To better manage the influx of SBIR/STTR proposals, awards, and companies—including many that were new to DOD or Air Force—Air Force instituted a range of measures. Some of the changes were specific to the open topics awards process. For example:

- **Recruiting volunteer evaluators throughout Air Force to evaluate open topics proposals and review contracts for small businesses selected for an award.** Evaluators must be government employees and are selected based on their subject-matter expertise and qualifications, such as education or prior commercial experience. Each evaluator on the panels reviews and scores the proposals on one of three main criteria. Then the scores are combined to get the overall score for the proposal. According to Air Force officials, this

<sup>13</sup>Throughout this report, we use “a few” to mean 2 or 3 of the 12 SBIR or STTR awardees we interviewed. We use “some” to mean 4 or 5 of the awardees and “many” to mean 6 or more.

differs from the conventional process in which evaluators and a technical point of contact are identified prior to a topic being included in a solicitation, and are involved in developing the topic. Also, volunteers are recruited to review contracts to ensure they meet all of the open topics proposal requirements. According to Air Force officials, between 300 and 1,000 technical evaluators and between 50 and 70 contracting officers and specialists may review proposals and contracts, depending on the number of proposals in the awards cycle and the level of response to calls for volunteers.

- **Creating events and online resources to help small businesses navigate the application process and identify potential Air Force end-users or purchasers of the technologies to be developed.** According to Air Force officials, in-person events, which became virtual with the onset of the COVID-19 pandemic, promote conversations between awardees and Air Force, allowing the small businesses to get oriented and make connections with potential Air Force end-users. Air Force holds these events at least once per solicitation cycle. Air Force has also hosted weekly webinars, which are archived on the AFWERX website, along with other resources. AFWERX has also created online resources for companies to share information and manages an online list of “focus areas” or problems needing a technical solution, outside of a SBIR/STTR solicitation.

Representatives of a few companies in our non-generalizable sample described such events and resources as helpful. One representative said their company, which received an open topics Phase I award, forged a productive relationship with the Air Force official who had submitted a focus area to AFWERX. The representative said that the official also signed the support memorandum, which the company used to apply for a Phase II open topics award.

- **Streamlining Phase I proposal requirements under the open topics process.** The open topics Phase I process requires a potentially shorter, simpler proposal. In a recent solicitation, Air Force required applicants for Phase I open topics awards to submit no more than 15 slides from an Air Force template and a technical white paper which may not exceed 15 pages. For Phase I proposals under the conventional process, the required white paper may be longer, up to 25 pages in a recent solicitation. Representatives of one company in our non-generalizable sample described the proposal preparation of 15 slides as easy compared with other SBIR/STTR applications that require many more pages.
- **Centralizing SBIR/STTR contracting in June 2019 to prioritize SBIR/STTR awards and reduce contract award times.** Air Force

conducted a pilot program to centralize contracting for SBIR/STTR awards and related functions, such as financial management. According to the pilot's charter, centralization was needed to improve the speed of SBIR/STTR contract issuance; promote consistency of SBIR/STTR contracting practices across Air Force; and address new workload demands caused, in part, by the increase in Air Force's SBIR/STTR budget.

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### Implementation of the New Process Was Sometimes Difficult

Although Air Force implemented various measures, its rapid expansion of the open topics process and increase in the SBIR/STTR budget sometimes made for a difficult implementation, according to our analysis of Air Force documents, representatives of companies in our non-generalizable sample of SBIR/STTR awards, and our prior work.

Air Force has changed its goals for the open topics process since FY 2018. According to the June 2020 letter from the Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics, the agency initially expected open topics awards to comprise 80 percent of its SBIR/STTR budget by FY 2022. The remaining 20 percent of the budget would be used for Air Force's conventional awards. In December 2021, Air Force officials told us that this goal for open topics included 20 percent for supplemental Phase II awards, such that open topics would comprise around 60 percent of Air Force's SBIR/STTR budget. In January 2022, Air Force officials told us that goal had been revised. Specifically, they said that open topics and conventional awards would each comprise around 40 percent of Air Force's SBIR/STTR budget, with supplemental Phase II awards to comprise the remaining 20 percent.

As we reported in October 2021, the rapid shift to open topics caused confusion in Air Force organizations involved with SBIR/STTR, resulting in hundreds of unissued awards.<sup>14</sup> Air Force officials told us in July 2021 that only conventional awards were affected. According to Air Force officials we interviewed for our prior report, the changes occurred without clear guidance and direction on the implementation of the new process and the amount of available funding for awards. This led to hundreds of instances in which small businesses (1) were selected for an award that

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<sup>14</sup>GAO, *Small Business Research Programs: Agencies Should Further Improve Award Timeliness*, [GAO-22-104677](#) (Washington, D.C.: Oct. 14, 2021).

was not issued, (2) submitted proposals that received no response, or (3) were not invited to submit a phase II proposal. Furthermore, in commenting on a draft of this report, Air Force stated that a reorganization of the SBIR/STTR program under AFWERX also contributed to these issues.

We recommended that the Secretary of the Air Force document policies and procedures for the Air Force team tasked with addressing the unissued awards. As of April 2022, Air Force had not yet taken action to address the recommendation. According to Air Force officials we interviewed in November 2021 and Air Force's FY 2022 budget request, the agency expected to finish issuing these awards in FY 2023. As of April 2022, the officials said they now expected to issue the remaining awards by the end of May 2022.

In addition, representatives from some of the companies we interviewed from our non-generalizable sample of awards made in FY 2019 and 2020 cited challenges related to the influx of proposals, awards, and companies. They also noted challenges advancing to Phase II under the new process. The companies had experience with the open topics process, the conventional process, or both processes. Specifically:

- **Slow or inconsistent communication from Air Force.** Some of the awardees we interviewed said AFWERX was not responsive or slow in responding to questions, and two of the companies attributed this to AFWERX staff being overwhelmed by the level of interest from companies and questions about the new process. Representatives from two companies citing communication issues said Air Force contacts from prior SBIR awards were not familiar with the new process and could not advise the company on the process. Air Force officials said they began hiring new staff in FY 2022.
- **Challenges advancing beyond Phase I under the open topics process.** Despite the availability of resources created by Air Force to support open topics awardees in identifying potential Air Force or DOD end-users or purchasers of mature technologies, representatives for a few companies we interviewed expressed concern about not being able to advance to Phase II. A representative from one company said the dozens of Air Force contacts they had made during an open topics Phase I award had expressed enthusiasm for his company's technology but never provided a support memorandum required for a Phase II award. The representative said that the contacts were unsure about the new process. He said that while open topics was an appealing concept,

the conventional process was clearer, because the mission need and potential end-user was known to the company. Representatives of other companies also said that potential end-users or purchasers, though interested, were unfamiliar with the need for a memorandum, and it was difficult to get them to respond in time for the company to apply for Phase II.

Other representatives said they did not receive a Phase II award, after obtaining a signed support memorandum. After funding a Phase I award, Air Force informed one such company that its technology did not meet certain SBIR/STTR eligibility requirements. Air Force officials explained that advancement to Phase II is not guaranteed. They further stated that the company's R&D relied on commercially available technologies that would not undergo sufficient modification during the SBIR award in order to meet the minimum SBIR/STTR requirements for funding R&D.

Other representatives said their companies were turned down for a Phase II award. Air Force officials said that companies may be selectable for an award, but were not as qualified as companies receiving a Phase II award from the available funding. Others that received a Phase II award said they did not benefit from the events or other measures taken by Air Force to help companies identify potential end-users or purchasers. Companies said they benefited more from using their contacts from previous SBIR/STTR awards or generating new contacts by marketing their technology capabilities on their own. Another representative said the company has pivoted away from responding to open topics solicitations. The representative said the company has good ideas but, with so little guidance on what to pitch, did not have time to submit a bunch of proposals that may get overlooked.

Air Force officials said that, in considering Phase II proposals, they scrutinize the support memoranda for evidence of a clear mission need and strong support from a likely end-user or purchaser of the proposed technology. The officials said that, by design, the process is competitive and around 20 percent of open topics Phase I awardees receive Phase II awards. The officials said that, while limiting the availability of Phase II funding would likely screen out some viable technologies, the new process prioritizes small businesses with the highest-rated proposals. The officials also said that businesses denied a Phase II award could reapply for SBIR/STTR under a direct-to-Phase II solicitation or seek non-SBIR/STTR funding.

In addition, a few of the company representatives said they found it difficult to transition to Phase III non-SBIR/STTR contracts. One

company said that Air Force could have provided guidance or support for the certifications needed for a Phase III award, such as those needed before they can sell software products to the federal government. One company's representatives who said they were unable to transition to a Phase III contract to test their technology and had to find and compete for an equivalent opportunity. Air Force officials said that difficulties with transitioning to Phase III are not unique to companies that participated in the open topics or conventional SBIR/STTR awards process.

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## New Process Is More Effective than Air Force's Conventional SBIR/STTR Process by Some Measures, but Assessment Gaps Exist

Air Force's open topics process was more effective than its conventional process in some ways, such as attracting new companies to Air Force and reducing the time needed to issue SBIR/STTR awards. Early evidence from the April 2021 study of open topics—one of the two evaluations issued on the effectiveness of the open topics process—also suggests that the new process was more effective in helping companies commercialize technologies. However, assessment and data gaps, particularly in Air Force's 2021 impact report on the open topics process, limit the agency's ability to fully assess open topics' effectiveness in commercialization and other areas.

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### New Process Attracted New Companies to Air Force

Our analysis showed that Air Force's open topics awards process was more effective than the conventional SBIR/STTR process at attracting companies new to federal contracting and Air Force. Open topics awards were more geographically dispersed than conventional awards but more concentrated in certain technology sectors. The open topics process had lower average rates of participation than the conventional SBIR/STTR process for women-owned or disadvantaged small businesses.

**Open topics attracted new companies to federal contracting and Air Force.** Open topics awardees had fewer prior federal contracts, on average, than conventional awardees and, thus, were newer to federal contracting. In our analysis of data on Air Force SBIR/STTR awards and federal contracting data from FPDS-NG, 1,001 companies received open topics awards. We identified that about 43 percent of these companies

had no prior federal contracts. The open topics awardees in our analysis averaged about 6 prior federal contracts. In contrast, 771 companies in our analysis received conventional awards in FY 2016 through 2020; 14 percent of those awardees had no prior federal contracts. The conventional awardees had, on average, around 21 prior federal contracts.<sup>15</sup>

Open topics awardees were also more likely to be new to Air Force contracting. For 56 percent of the 1,001 companies receiving open topics awards, those awards constituted their first Air Force SBIR or STTR award, compared to 33 percent (253 out of 771) for conventional awardees.<sup>16</sup>

These results are generally consistent with results from the April 2021 study of open topics, which found that companies applying for open topics awards had, on average, fewer Air Force SBIR/STTR awards than companies applying for conventional awards and, overall, fewer DOD contracts.<sup>17</sup> Although the April 2021 study used a different time period and methodology than our analysis, our respective analyses support similar conclusions that open topics companies are newer to federal and Air Force contracting. Air Force's 2021 impact report on the open topics process also included data on open topics awardees' prior contracting

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<sup>15</sup>In this analysis, 1,001 companies received open topics awards in FY 2018 through 2020, and 771 received conventional Air Force SBIR/STTR awards in FY 2016 through 2020. We counted the number of prior federal contracts in FPDS-NG between October 1, 2010, and the date of the companies' first open topics or conventional award (including that award). The results above include companies that exclusively received either open topics or conventional awards and does not reflect the 208 companies in this analysis receiving both types of awards in FY 2016 through 2020. The companies receiving both types of awards had, on average, 22.7 or 32.8 prior federal contracts since October 1, 2010, depending on whether the companies' first Air Force SBIR/STTR award in FY 2016 through 2020 was an open topics (22.7 average) or conventional award (32.8 average).

<sup>16</sup>These results include the companies that exclusively received either open topics awards in FY 2018 through 2020 or conventional Air Force SBIR/STTR awards in FY 2016 through 2020. Results for the 208 companies in this analysis that received both types of awards in FY 2016 through 2020 are not reflected above.

<sup>17</sup>The study, which looked at data on Air Force SBIR/STTR applicants—including awardees and non-awardees—from 2017 through 2019, found that 69 percent of the 1,659 applicants for open topics awards had no prior SBIR awards, compared to 28 percent of 4,995 applicants for conventional awards. The study also found that open topics applicants had, on average, around 12 prior DOD non-SBIR/STTR contracts compared to 20 for conventional award applicants.

experience but did not compare the results to Air Force's conventional awardees.

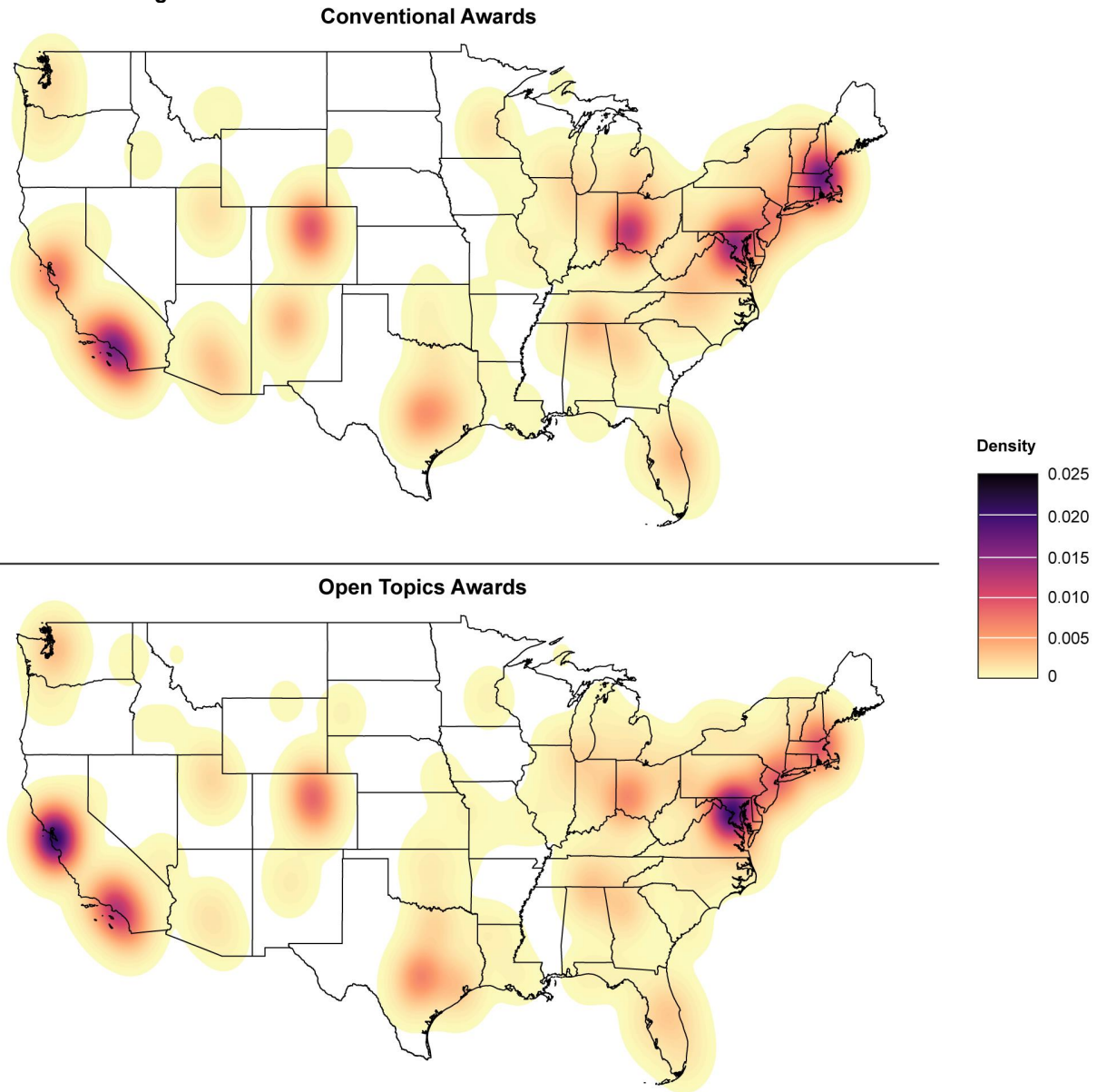
**Open topics awardees are more geographically dispersed.** Our analysis of SBIR/STTR awards found that open topics companies were geographically dispersed in more U.S. zip codes than conventional awardees. The over 1,800 open topics awards in FY 2018 through 2020 occurred in 927 unique zip codes, while a similar number of conventional awards in those years were in 645 zip codes. To identify geographic areas where awards were most concentrated, we analyzed the density of award locations based on each award zip code. According to our analysis, open topics awards were concentrated in Silicon Valley, a commercial technology and R&D hub in Northern California. The authors of the April 2021 study of open topics also reported this finding. Open topics awards were also more concentrated around Washington, D.C. Conventional awards were concentrated in Colorado, Eastern Massachusetts, Southern California, and Southern Ohio. These areas include Air Force bases with primary missions such as R&D, purchasing, and space defense, and which may be located near other R&D hubs, such as Boston and Los Angeles (see fig. 3).<sup>18</sup>

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<sup>18</sup>According to the U.S. Patent and Trademark Office, the Boston-Cambridge-Quincy and Los Angeles-Long Beach-Santa Ana metropolitan statistical areas were among the top five such areas in the number of utility patents granted in 2000 through 2015. The other such areas in the top five included San Jose-Sunnyvale-Santa Clara and San Francisco-Oakland-Fremont in California and New York-Northern New Jersey-Long Island.



**Figure 3: Locations of Companies Receiving Conventional (top) and Open Topics (bottom) Air Force SBIR/STTR Awards in Fiscal Years 2018 through 2020**



Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) award data. | GAO-22-105223

Note: The density shading represents the likelihood that a randomly selected open or conventional topics award will be located in the covered area. Darker tones represent areas with a higher concentration of awards. Because of the scale of the map, the shading may extend into areas with few or no awards. This map is for illustrative purposes only for mapping the distribution of awards using zip code level data and should not be used to make inferences about statistically significant clusters of awards.

**Open topics companies were more concentrated in certain technology sectors.** According to our analysis of funding information from Air Force, nearly 83 percent of the Phase II open topics award dollars in FY 2019 through 2020 were concentrated in 10 technology sectors, such as space technologies, artificial intelligence, and biotechnology.<sup>19</sup> In contrast, conventional award dollars in FY 2016 through 2020 were more evenly spread, with around 68 percent of Phase II conventional award dollars going to the top 10 sectors. Some technology sectors, such as space technologies and artificial intelligence and machine learning, appeared in the top 10 for both open topics and conventional awards, whereas sectors such as hypersonic weapons and augmented/virtual reality appeared just once (see table 2). For information on Air Force SBIR/STTR funding for all 25 technology sectors, see appendix II.

**Table 2: Top 10 Technology Sectors Based on Percentage of Dollars Awarded for Air Force Phase II Open Topics and Conventional SBIR/STTR Awards in Fiscal Years 2016 through 2020**

Rank	Open topics awards <sup>a</sup>		Conventional awards	
	Technology sector	Percentage	Technology sector	Percentage
1	Space technologies	13.7	Space technologies	13.6
2	Artificial intelligence and machine learning	12.8	Fully networked command, control, and communications	9.7
3	Fully networked command, control, and communications	10.3	Hypersonic weapons	8.2
4	Augmented/virtual reality	10.0	Sensing	7.2
5	Autonomy	8.7	Autonomy	5.6
6	Cyber operations and security	8.4	Sustainment	5.6
7	Enterprise/business management	6.5	Cyber operations and security	4.7
8	Biotechnology	5.3	Coatings and platings	4.7
9	Sustainment	3.8	Microelectronics	4.6
10	Training	3.3	Artificial intelligence and machine learning	4.2

Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) award data. | GAO-22-105223

<sup>a</sup>Air Force only awarded Phase II open topics awards in fiscal years 2019 and 2020.

<sup>19</sup>Air Force provided us an analysis of the dollars awarded in FY 2016 through 2020 for its Phase II open topics and conventional awards for 25 technology sectors. The Air Force provided this analysis in response to our request for data on SBIR/STTR for Air Force missions. Because open topics Phase II awards were available in two of the five years (fiscal years 2019 and 2020), we are reporting percentages rather than raw dollar amounts. See appendix II.

**Open topics companies were less diverse.** According to our analysis and the April 2021 study, average rates of participation of women-owned or socially and economically disadvantaged small businesses in Air Force SBIR/STTR were lower for open topics awardees. The participation rates for open topics and conventional awardees were lower in our analysis than in the April 2021 study.<sup>20</sup> The 2021 impact report did not include information on women-owned small businesses and, as we discussed earlier, did not compare open topics and conventional awardees. Neither the April 2021 study nor the impact report included rates of participation by businesses in historically underutilized business zones (HUBZones).<sup>21</sup> According to our analysis, the percentage of awardees located in HUBZones was the same for open topics and conventional SBIR/STTR awardees (see table 3).<sup>22</sup>

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<sup>20</sup>The April 2021 study analyzed data on Air Force SBIR/STTR applicants—including awardees and non-awardees—from 2017 through 2019. The difference in participation rates for open topics and conventional applicants was statistically significant for rates of participation by women-owned small businesses but not by socially and economically disadvantaged small businesses, according to the authors.

<sup>21</sup>The HUBZone program aims to stimulate economic development in distressed areas by offering preferences in federal contracting to SBA-certified HUBZone businesses. See GAO, *Small Business Contracting: Small Business Administration Could Further Strengthen Eligibility Reviews in Puerto Rico and Programwide*, [GAO-18-666](#) (Washington, D.C.: Sept. 24, 2018).

<sup>22</sup>The April 2021 study found that the open topics applicant companies were smaller, on average, than Air Force's conventional SBIR/STTR applicant companies. Open topics applicant companies had an average of 26.9 employees (median of 8 employees), and conventional applicant companies had an average of 60.8 employees (median of 20 employees). See appendix I for more information.

**Table 3: Rates of Participation By Women-Owned and Disadvantaged Small Businesses in Air Force’s Open Topics and Conventional SBIR/STTR Awards Processes**

Study	Open Topics Applicants	Conventional Applicants	Open Topics Awardees		Conventional Awardees
	April 2021 study <sup>a</sup>	April 2021 study <sup>a</sup>	GAO’s Analysis <sup>b</sup>	Air Force Impact Report (2021) <sup>c</sup>	GAO’s Analysis <sup>b</sup>
Women-owned Small Businesses	11.1 percent	15.5 percent	9.6 percent	–	12.6 percent
Socially and Economically Disadvantaged Small Businesses (formerly, Minority-owned Small Businesses)	12.1 percent	12.7 percent	5.9 percent	11.9 percent	6.9 percent
HUBZone Businesses	–	–	2 percent	–	2 percent

Legend: A dash (–) denotes that the category was not assessed in the evaluation report.

Source: (1) Howell et al., Opening up Military Innovation: Causal Effects of ‘Bottom-up’ Reforms to U.S. Defense Research, National Bureau of Economic Research (NBER) Working Paper No. 28700 (published Apr. 2021); (2) GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) award data; and (3) Air Force, *AFVentures FY18-20 Impact Report* (2021). | GAO-22-105223

<sup>a</sup>The April 2021 study included SBIR/STTR applicant data for 2017 through 2019, including companies that were selected for an open topics or conventional award and companies that competed for those awards but were not selected. The difference in women-owned businesses is statistically significant (p-value: ~0.000). The difference in socially and economically disadvantaged small businesses is not statistically significant (p-value: 0.523).

<sup>b</sup>The GAO analysis includes open topics awards in FY 2018 through 2020 or conventional awards in FY 2016 through 2020. The difference in women-owned businesses is statistically significant (p-value: 0.001). The difference in socially and economically disadvantaged small businesses is not statistically significant (p-value: 0.146). We found no statistically significant difference for HUBZone Businesses.

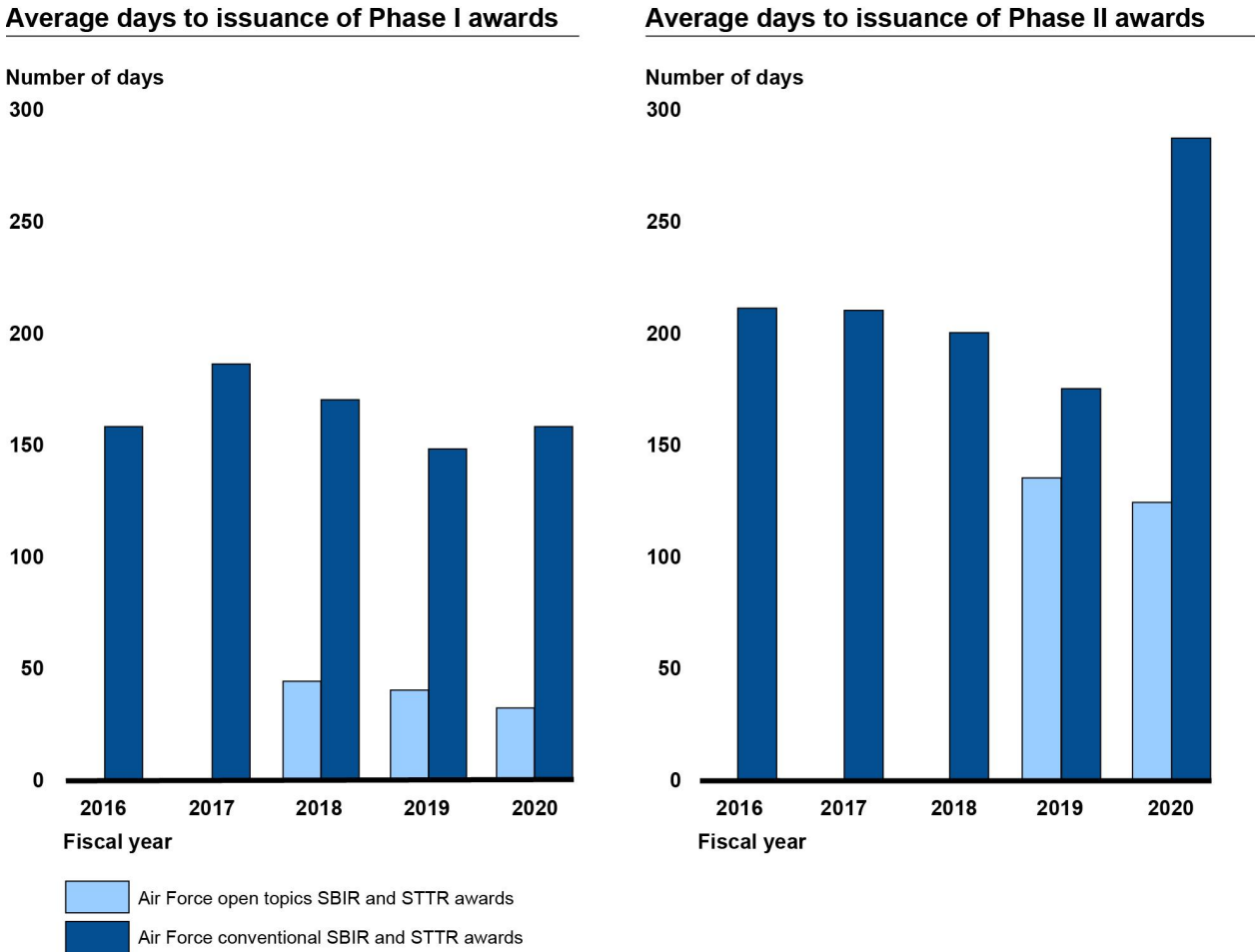
<sup>c</sup>The AFVentures impact report included open topics award and company data for fiscal years 2018 through 2020.

## Air Force Issued SBIR/STTR Awards Faster Under Its New Process

Under its new process, Air Force issued its SBIR/STTR award more quickly, reducing the time from solicitation close to SBIR/STTR contract award, particularly for Phase I awards. Compared to conventional awards, Air Force took, on average, 108 fewer days in FY 2019 and 126 fewer days in FY 2020 to evaluate Phase I open topics proposals and to issue SBIR or STTR contracts. Air Force also took fewer days, on average, to evaluate Phase II open topics proposals and issue

contracts—40 fewer days in FY 2019 and 163 fewer in FY 2020 (see fig. 4).<sup>23</sup>

**Figure 4: Average Number of Days between Solicitation Close Date and Contract Issuance of Air Force Open Topics and Conventional Phase I and Phase II SBIR/STTR Awards, Fiscal Years 2016 through 2020**



Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) award data. | GAO-22-105223

<sup>23</sup>Phase I open topics awards were also far more likely to meet the timeliness standard in SBA’s SBIR/STTR policy directive, which recommends that Air Force and most agencies issue awards within 180 days of the solicitation close date. Previous reports, such as [GAO-22-104667](#), reported in detail on Air Force and other agencies’ SBIR/STTR award timeliness.

**Accessible Data Table for Figure 4**

	<b>Fiscal Year</b>	<b>Phase</b>	<b>Average days to issuance</b>
Air Force conventional SBIR and STTR awards	2016	1	158
Air Force conventional SBIR and STTR awards	2016	2	211
Air Force conventional SBIR and STTR awards	2017	1	186
Air Force conventional SBIR and STTR awards	2017	2	210
Air Force conventional SBIR and STTR awards	2018	1	170
Air Force conventional SBIR and STTR awards	2018	2	200
Air Force conventional SBIR and STTR awards	2019	1	148
Air Force conventional SBIR and STTR awards	2019	2	175
Air Force conventional SBIR and STTR awards	2020	1	158
Air Force conventional SBIR and STTR awards	2020	2	288
Air Force open topics SBIR and STTR awards	2018	1	44
Air Force open topics SBIR and STTR awards	2019	1	40
Air Force open topics SBIR and STTR awards	2019	2	135
Air Force open topics SBIR and STTR awards	2020	1	32
Air Force open topics SBIR and STTR awards	2020	2	125

We observed these faster award times for open topics awards in FY 2019 and 2020, even with the significant increase in proposals received by Air Force. Air Force officials told us that some of the changes previously discussed, such as reducing the required length of Phase I proposals and recruiting evaluators throughout Air Force, helped them evaluate proposals and issue open topics awards more quickly. In addition, the officials said that centralizing and consolidating Air Force’s open topics SBIR/STTR contracting helped improve contracting award times.

However, Air Force officials said that proposal evaluation and issuance of SBIR/STTR contracts for conventional awards has remained largely

decentralized throughout Air Force, with offices that make conventional awards allowed to follow their own processes. Since assuming responsibility for the conventional process in January 2022, AFVentures has begun taking steps to better manage the decentralized process, according to Air Force officials. Those steps have included designating a conventional topics program manager and tracking the conventional awards process and spending. Air Force has historically had longer award times for its conventional SBIR/STTR awards, as illustrated in figure 4 and in our previous reports on SBIR/STTR award timeliness.<sup>24</sup>

Faster award times were possible under the conventional SBIR/STTR process with an approach which Air Force has used for a limited number of conventional SBIR/STTR awards, mainly for Phase I. This approach is separate from open topics awards but with similarities. Since 2019, Air Force SBIR/STTR solicitations have included some broad topics (though less so than open topics) and often had an associated “pitch day” event, which took place after the solicitation was closed. Some of these topics have focused on particular weapons or technology areas, such nuclear weapons, artificial intelligence, or advanced manufacturing, and invited companies to propose technology solutions to an Air Force need. Applicants invited to a pitch day event present their proposal to Air Force personnel from mission organizations sponsoring the event. According to our analysis, award times for Phase I SBIR/STTR contracts involving pitch day topics were faster, on average, than for conventional Phase I awards overall (including pitch day awards), but not as fast as open topics awards (see table 4). Air Force officials told us that pitch day awards are faster than other conventional awards, because Air Force follows a condensed award timeline to prepare for the planned pitch day.

**Table 4: Comparison of Award Times for Air Force Pitch Day, Conventional, and Open Topics Phase I SBIR/STTR Awards in Fiscal Years 2019 through 2020**

	Pitch Day Awards	Conventional Awards	Open topics Awards
Number of awards	124	649	1,314
Average contract award time <sup>a</sup>	57 days	172 days	35 days

<sup>24</sup>In FY 2016 through 2018, Air Force took 187 days, on average, to issue SBIR/STTR awards, issuing 54 percent of its awards within the recommended 180-day period. Because the open topics process began with only 50 awards in FY 2018, most of the awards in FY 2016 through 2018 were conventional SBIR/STTR awards. See GAO, *Small Business Research Programs: Many Agencies Took Longer to Issue Small Business Awards than Recommended*, [GAO-19-620](#). (Washington, D.C.: Sept. 26, 2019).

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Award time range<sup>b</sup>    28 days to 154 days    13 days to 397 days    12 days to 177 days

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Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) award data. | GAO-22-105223

<sup>a</sup>Average days between solicitation close and SBIR/STTR contract issuance.

<sup>b</sup>Range of days between solicitation close and SBIR/STTR contract issuance. For conventional awards, we removed 10 likely invalid responses.

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## One Study Found New Process Helps Awardees Obtain Subsequent DOD Contracts and Venture Capital

Using data from early in the program, the authors of the April 2021 study found that the open topics process helps participating small businesses commercialize technologies to a greater extent than Air Force’s conventional SBIR/STTR process. The study looked at applicants for open topics and conventional awards, both awardees and non-awardees. While some of the open topics and conventional awardee and non-awardee companies included in the study received subsequent DOD contracts or venture capital, according to the study, receiving an open topics award provided an advantage.<sup>25</sup>

The authors compared commercialization achievements of companies selected for Air Force open topics or conventional SBIR/STTR awards to a control group of comparable companies that competed for those awards but were not selected.<sup>26</sup> The study found that companies receiving open topics awards in 2018 or 2019 were, on average, 7.5 percentage points more likely than comparable companies not selected for those awards to

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<sup>25</sup>The subsequent DOD contracts to the companies in the April 2021 study may or may not be related to the technology developed during the SBIR/STTR award.

<sup>26</sup>The authors used statistical weighting of their study data to, effectively, simulate experimental “treatment” and “control” groups, respectively, of SBIR/STTR awardees and non-awardees. The companies in these groups received similar evaluation scores from Air Force on their SBIR/STTR proposals, just above or below Air Force’s numerical cutoff-line for selecting awardees. Because the scores were similar, the authors determined that the companies in the treatment and control groups were comparable for the purposes of the study. The authors’ primary estimates are based on regression analysis using companies’ first proposals between 2017 and 2019 and include controls to account for differences across award competitions.



subsequently receive a non-SBIR/STTR contract with Air Force or another DOD agency.<sup>27</sup>

Similarly, the open topics awardees were 5.2 percentage points more likely than the companies not selected for those awards to obtain subsequent venture capital funding.<sup>28</sup> These effects were statistically significant, according to the study. In contrast, being selected for a conventional Air Force SBIR/STTR award in 2017, 2018, or 2019 had no statistically significant effect on the companies' chances of receiving non-SBIR/STTR DOD contracts or venture capital.<sup>29</sup>

While the study suggests that open topics awardees have an advantage, the results reflect the process's early implementation from its introduction in 2018 through the first full year of implementation in 2019. Since then, hundreds more open topics and conventional awards have been issued, and Air Force has implemented program changes. Also, companies that received open topics or conventional SBIR/STTR awards during that time will have had more time to commercialize their technologies, which Air Force and DOD officials from OUSD R&E told us can take years.

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<sup>27</sup>The ninety-five percent confidence interval was from 0.6 to 14.4 percentage points. From data tables in the August 2021 update of the study, we estimated that roughly 18.1 percent of open topics awardees just above the cutoff line subsequently received a non-SBIR/STTR contract with Air Force or another DOD agency, compared to roughly 10.6 percent for non-awardees just below the cutoff line.

<sup>28</sup>The ninety-five percent confidence interval was from 0.1 to 10.3 percentage points. From data tables in the study's August 2021 update, we estimated that roughly 10.9 percent of open topics awardees just above the cut-line received subsequent venture capital, compared to roughly 5.7 percent for non-awardees just below the cut-line.

<sup>29</sup>Based on data tables in an August 2021 update of the April 2021 study, we estimated that roughly 35.2 percent of conventional Air Force SBIR/STTR awardees just above the cutoff line received a subsequent non-SBIR/STTR DOD contract compared to 31.9 percent of non-awardees just below the cutoff line. We also estimated that roughly 1.4 percent of the conventional awardees just above the cutoff line received subsequent venture capital compared to 2.0 percent of non-awardees just below the line.

In addition, the authors studied whether receiving an open topics or conventional Air Force SBIR or STTR award affected the companies' likelihood of earning subsequent patents or SBIR contracts. They reported that open topics awardees were 5.1 percentage points more likely to obtain subsequent patents than the companies that competed for the open topics awards but were not selected. They also reported that conventional awardees were 13.7 percentage points more likely to obtain subsequent SBIR contracts than companies not selected for conventional awards. Both of these effects were statistically significant, according to the study.

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## Gaps Exist in Air Force Assessments of Commercialization and Company Diversity

Assessment and data gaps made it difficult to fully evaluate the effectiveness of the open process in technology commercialization, technical progress of SBIR/STTR awards, and company diversity. These gaps could potentially result in overstating or understating, or otherwise limit Air Force's ability to assess, the new process's effectiveness in these areas.

**Technology Commercialization.** Limitations of the federal procurement data used to identify Phase III contracts—contracts and subcontracts resulting from Phase I or Phase II SBIR/STTR awards—and lack of data on technical progress in SBIR/STTR awards make it more difficult to evaluate the effectiveness of the open topics process in helping companies commercialize their technologies.

Air Force officials and DOD SBIR/STTR program officials from the OUSD R&E discussed specific challenges with identifying Phase III contracts or subcontracts using FPDS-NG. For example:

- FPDS-NG, may not reliably identify Phase III contracts, according to Air Force and OUSD R&E officials. OUSD R&E officials said that, as part of DOD's mandatory annual reporting to SBA, they compare data on Phase I and Phase II awards from DOD's SBIR/STTR portal to information on Phase III contracts in government-wide systems including FPDS-NG. The officials said the systems rely on personnel entering the data to accurately identify Phase III contracts. They said non-Phase III contracts were sometimes misidentified as Phase III contracts and that legitimate Phase III contracts were not correctly flagged in FPDS-NG. The OUSD R&E officials said they have had to manually verify some potential Phase III contracts. The officials said that process can take many hours and require a significant amount of manpower.
- The OUSD R&E officials said that some Phase III contracts may not be included in FPDS-NG. For instance, Phase III work performed under lower-tier subcontracts may not be reported into federal contracting systems. As small businesses, SBIR/STTR companies often receive federal subcontracts contracts below the first tier, for example, to work on components of a larger DOD platform. According to the OUSD R&E officials, lower-tier Phase III awards may not be

reported in federal contracting data, as federal contractors are not required to report on subcontracts below the first tier.

- We attempted to match potential Phase III contracts in FPDS-NG to Air Force SBIR/STTR award data we collected for FY 2018 through 2021 but were unsuccessful in doing so reliably. We used company identifiers, award dates, research titles and abstracts, and other data fields to match subsequent contracts to Phase II SBIR/STTR awards. Although the process turned up many likely matches by company identifier, limitations in FPDS-NG's descriptions of the technologies made it difficult or impossible to systematically link SBIR/STTR awards with Phase III contracts.

The effect, if any, of these limitations is unknown on evaluations that use FPDS-NG, such as the April 2021 study and Air Force's 2021 impact report on the open topics process. The April 2021 study's authors used the study's design to try and isolate the effects of participation in Air Force's open topics or conventional SBIR/STTR processes. The results showed a statistically significant increase in subsequent contracts for open topics companies, as discussed, but the study authors told us they did not attempt to link individual DOD contracts to the technologies in the open topics awards. In the 2021 impact report, Air Force reported that open topics companies earned \$1.42 billion in subsequent DOD contracts but cautioned that it did not attempt to draw a causal relationship between SBIR/STTR awards and subsequent contracts.

OUSD R&E officials told us that, as a result of such data gaps, DOD or its components commissioned three outside studies to estimate the economic impact of Air Force, Navy, and DOD SBIR/STTR awards. Reports were issued in 2015, 2016, and 2019 respectively. The researchers surveyed as many as 3,844 SBIR/STTR awardees about the economic impacts of their awards, including sales of new products from those awards, dollars from technology licensing and private investment, and other outcomes.<sup>30</sup> According to the reports, the research teams, consisting of multiple staff, achieved response rates between 86 and 96 percent and took around 1 to 2 years to complete each study. All three studies reported positive results. The study of Air Force's conventional SBIR/STTR program reported sales of new products and services based on innovations developed under Phase II contracts in 2000 through 2013.

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<sup>30</sup>TechLink, *National Economic Impacts from the Air Force SBIR/STTR Program, 2000-2013* (2015); *National Economic Impacts from the Navy SBIR/STTR Program, 2000-2013* (2016); *National Economic Impacts from the DOD SBIR/STTR Program, 1995-2018* (2019).

However, we found the estimated benefits are likely overestimated due to limitations in the methodologies used by the studies, such as lack of a control group.

**Technical Progress of SBIR/STTR Awards.** Air Force does not systematically assess the technical progress companies achieve during their SBIR/STTR awards and is not required to do so. Because the open topics program targets commercial companies with potential dual-use technologies for Phase I funding, measuring subsequent commercialization, without accounting for the starting maturity of the technologies funded, could overstate open topics' effectiveness in helping companies commercialize their technologies. Measures of technical progress, such as starting and ending technology readiness levels (TRL), provide a systematic measure of technical maturity and could be used to help account for differences in open topics or conventional SBIR/STTR technologies' starting maturity.<sup>31</sup> We found evidence of such differences in our analysis of contract file documents from our non-generalizable sample of 17 SBIR/STTR awards. We analyzed proposals and other contract file documents to gain some insights on technical progress. We observed that more of the open topics awards in our sample appeared to involve R&D of technologies which had previously been commercialized. This was the case with fewer of the conventional awards in our non-generalizable sample, some of which involved R&D of less mature technologies. See appendix I for more information.

Air Force officials told us they are not required to measure TRLs of SBIR/STTR projects and would consider commercialization success to be a more efficient measure. Instead, the officials said that Air Force technical points of contact monitor technical progress and evaluate awardees' contractually required deliverables, such as technical reports or working technologies, for Air Force acceptance.

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<sup>31</sup>A nine-point TRL scale used in DOD and other federal agencies provides those agencies, their contractors, and others a common benchmark for assessing the maturity of integrated technologies or individual components as ranging from TRL-1, the early translation of scientific principals into applied R&D, to early integration of components (TRL-4), prototyping (TRL-5 through TRL-7), system testing and qualification (TRL-8), and successful mission use (TRL-9). See GAO, *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects*, [GAO-20-48G](#) (Washington, D.C.: Jan. 2020).

**Company Diversity.** Other assessment and data gaps also limit Air Force's ability to assess the effectiveness of the open topics process in attracting diverse companies, particularly in Air Force's 2021 impact report on the open topics process. For example:

- Air Force's impact report did not include information on participation by women-owned small businesses. The committee report accompanying the National Defense Authorization Act for Fiscal Year 2021 called for Air Force's assessment of the open topics process according to the letter and intent of the SBIR statute, including expanding SBIR access to diverse businesses across the U.S. that are women owned and socially or economically disadvantaged. In the June 2020 letter, the Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics stated Air Force intended to make data-driven decisions to ensure the open topics process complies with the laws governing the SBIR program. DOD already collects data on which SBIR/STTR companies are women-owned. In its SBIR/STTR application portal, DOD requires all SBIR/STTR companies to indicate with each new application whether they are a women-owned small business. In written responses from February and March 2022, Air Force officials said they did not know why the category was not included in Air Force's 2021 impact report but would consider it in future reports on the effectiveness of the open topics process.<sup>32</sup>
- Air Force did not assess the reliability of its data on disadvantaged businesses used in the impact report. Assessing the reliability of data involves examining whether the data are sufficiently accurate, complete, and applicable for a particular purpose, in part, by checking the data for outliers or comparing to other records or data sources, among other possible steps.<sup>33</sup> Air Force used the government-wide

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<sup>32</sup>Likewise, other Air Force SBIR/STTR reports did not include rates of participation by women-owned small businesses, whether for the open topics or conventional awards processes. See, for example, Air Force, *2020 Year in Review: Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)*.

<sup>33</sup>See, for example, GAO, *Assessing Data Reliability*, [GAO-20-283G](#) (Washington, D.C.: Dec. 2019).

system, SAM.gov, as its source for these data in its report.<sup>34</sup> In written responses, Air Force officials could not describe what steps they took to check the reliability of the SAM.gov data. Such steps could include comparing SAM.gov to data collected routinely in DOD's SBIR/STTR application portal. Both systems collect data on socially and economically disadvantaged small businesses and HUBZone businesses.<sup>35</sup> In their written responses, the Air Force officials said that that SAM.gov provided data on a wider variety of disadvantaged business types than other sources.

- To report on open topics awardees' business size (number of employees) in its 2021 impact report, Air Force used an external data source that may not be regularly updated, despite having access to more current data collected from SBIR and STTR applicants. Because businesses are not required to update their size in the external data source used in the impact report, and because business size can change frequently, the data on business size in this data source may be out of date.

In written responses provided in February and March 2022, Air Force officials said that, after performing initial checks, they did not have any serious concerns about the reliability of the vendor's data. They also said they did not know how often SBIR/STTR companies updated their information on business size with the vendor, as the companies are not required to do so. Air Force officials did not check the vendor's data against more current data sources, such as DOD's SBIR/STTR portal, where companies report their business size with each new SBIR or STTR application. According to Air Force officials, they did not compare the external data source with the proposal data because the data is relatively recent and may have reliability issues of its own.

Federal internal control standards require agencies to use quality information in decision making, including relevant and reliable data for

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<sup>34</sup>The General Services Administration's System for Award Management (SAM) is a federal government-wide database for vendor data that is used across all federal agencies. Any entity that wishes to do business with the government must register in SAM to be eligible to receive a contract award and renew their registration annually, except in specific circumstances outlined in the law and FAR. (FAR § 4.1102.)

<sup>35</sup>HUBZones are historically underutilized business districts designated by SBA. While most of the disadvantaged business categories in SAM.gov are self-reported by companies, status as a HUBZone business is determined by SBA and cannot be self-reported, according to SAM.gov data documentation.

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assessing their programs.<sup>36</sup> Without reviewing the reliability of the data on disadvantaged business participation and business size, Air Force risks using data that is less current and accurate than the information the small businesses provide when applying for Air Force SBIR/STTR awards.

These assessment and data gaps limit Air Force's ability to evaluate the effectiveness of its open topics process in attracting small and socio-economically diverse companies. In contrast to other assessment and data gaps—particularly those related to technology commercialization and technical progress of SBIR/STTR awards—the gaps related to company size and diversity could be addressed with data Air Force already has on hand.

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## Conclusions

Air Force implemented the open topics award process, in part, to attract new business to the SBIR/STTR program and deliver technology solutions to the warfighter faster. To date, the new process has succeeded in providing more timely awards to small businesses that are more geographically dispersed and new to the Air Force's program. However, the impact of the program on the warfighter and participation in the program by disadvantaged businesses remains difficult to discern.

While Air Force has encouraging evidence that the open topics process leads to more commercialization, data gaps regarding Phase III contracting—gaps that Air Force cannot easily address—limit the extent to which Air Force can assess technology deployment. In addition, Air Force evaluations of company diversity may not provide reliable information. Air Force did not report participation in the new process by women-owned businesses in its 2021 impact report. Further, Air Force did not check the reliability of outside data sources used to identify disadvantaged businesses and company size, despite collecting similar data during the application process. By improving the data used in its reports, Air Force would have better information by which to assess the reach of the new open topics process and could potentially improve on its early evidence of success.

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<sup>36</sup>See GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 2014).

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## Recommendation for Executive Action

We are making a total of two recommendations:

- The Secretary of the Air Force should ensure that public reports on the effectiveness of the open topics SBIR/STTR process include information on participation by women-owned small businesses. (Recommendation 1)
- The Secretary of the Air Force should ensure that Air Force reviews its data on disadvantaged business participation and business size in the open topics process, including that the data are current and reliable for the purpose of monitoring the process's effectiveness in attracting such businesses and smaller companies. (Recommendation 2)

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## Agency Comments and Our Evaluation

We provided a draft of this report to DOD. We received written comments from DOD, which are reprinted in appendix III and summarized below. We also received technical comments from Air Force, which we incorporated in our report, as appropriate.

In its written comments, DOD stated that it concurred with the first recommendation and partially concurred with the draft report's second recommendation. Regarding the draft report's second recommendation, the agency commented that verifying data on small disadvantaged businesses, which Air Force obtains from SAM.gov, would necessitate a new re-verification process that goes beyond Air Force's role and federal regulations.

We have modified the recommendation's wording to clarify that we are not suggesting Air Force verify small businesses' status, as DOD suggests in its written comments. Rather, the intent of the recommendation was ensuring current and reliable data. We believe such a recommendation for Air Force to ensure that its data are current and reliable is warranted because we found Air Force took limited steps to review the data it obtained from SAM.gov and a private database. As we stated in the report, Air Force could, for example, review the reliability of its data by comparing data from these sources to DOD's own data, which it routinely collects from its SBIR/STTR applicants. As the DOD data may be more current, reasonable steps, such as comparing even a limited



sample of data from these sources, would give Air Force greater confidence in its knowledge of the reach and effectiveness of its open topics process. In its written comments, DOD stated Air Force will ensure that its internal process provides current and reliable data for monitoring effectiveness of its awards process but did not specify what actions it will take. By including the review of its data on disadvantaged business participation and business size in any process changes, Air Force would be better positioned to effectively monitor its awards process.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, and the Secretary of the Air Force. In addition, the report is available at no charge on the GAO website at <https://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-6888 or [WrightC@gao.gov](mailto:WrightC@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.



Candice N. Wright  
Director, Science, Technology Assessment, and Analytics

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*List of Committees*

The Honorable Jack Reed  
Chairman  
The Honorable James M. Inhofe  
Ranking Member  
Committee on Armed Services  
United States Senate

The Honorable Jon Tester  
Chairman  
The Honorable Richard Shelby  
Ranking Member  
Subcommittee on Defense  
Committee on Appropriations  
United States Senate

The Honorable Adam Smith  
Chairman  
The Honorable Mike Rogers  
Ranking Member  
Committee on Armed Services  
House of Representatives

The Honorable Betty McCollum  
Chair  
The Honorable Ken Calvert  
Ranking Member  
Subcommittee on Defense  
Committee on Appropriations  
House of Representatives

## Appendix I: Objectives, Scope, and Methodology

The committee report accompanying the National Defense Authorization Act for Fiscal Year 2021 includes provisions for GAO to review Air Force's open topics awards process for its Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) awards, including comparisons to Air Force's conventional SBIR/STTR awards process.<sup>1</sup> This report examines (1) how Air Force implemented the open topics process for its SBIR and STTR awards and (2) what is known about the effectiveness of the open topics process, as compared to Air Force's conventional SBIR/STTR awards process, in expanding SBIR/STTR access to a broader range of companies, reducing award processing times, and commercializing technologies. The scope of our review includes Air Force's SBIR/STTR awards and awards process from fiscal years (FY) 2016 through 2020 and, in particular, its open topics awards process, which Air Force implemented in June 2018 and operates in tandem with its longstanding conventional SBIR/STTR process.

To address the objectives, we (1) analyzed Air Force's SBIR/STTR award data from prior GAO studies for trends in open topics and conventional SBIR/STTR awards in FY 2016 through 2020; (2) analyzed federal contracting data; (3) examined contract files for a non-generalizable selection of 17 Air Force open topics and conventional SBIR/STTR contracts and interviewed representatives from 12 of the 17 awardee companies; and (4) conducted other analysis, document review, and interviews.

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<sup>1</sup>H. Rpt. 116-442 of the Committee on Armed Services, which accompanies the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283 (Jan. 1, 2021).

The House report included a provision for GAO to review and assess the Air Force's Ventures process and SBIR/STTR effort in (1) tracking commercialization of companies; (2) expanding SBIR access to more small businesses; (3) ensuring small businesses are financially secure by reducing time from solicitation to award; and (4) expanding SBIR access to businesses that are women-owned and socially and economically disadvantaged, as well as diverse geographically and by size. It further included a provision for GAO to provide trend analysis for no less than five years on (1) funding awarded to open versus conventional-SBIR topics; (2) entry and exit technology readiness levels for Phase I and Phase II awards; (3) process and capability to measure technical merit; and (4) which Air Force missions are receiving SBIR funding.

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## Analyses of Air Force's SBIR/STTR Award Data

To analyze trends in open topics and conventional SBIR/STTR awards, we used data on Air Force SBIR/STTR awards in FY 2016 through 2020, which we collected from Air Force and other agencies in 2019, 2020, and 2021 for prior GAO studies on SBIR/STTR award timeliness. These data included observations for thousands of Air Force SBIR/STTR awards and key data elements, such as company name, award date, award amount, SBIR/STTR program phase (Phase I or Phase II), and various award and company identifiers. As discussed in our prior reports, we took several steps to assess and improve the data's reliability and found the data to be sufficiently reliable for our purpose in those studies.<sup>2</sup>

To obtain additional data elements necessary for this review, we merged our data on award timeliness with specific data elements from Small Business Administration's (SBA) SBIR.gov website, which contains publicly available and downloadable award-level data for SBIR and STTR awards by participating agencies, including Air Force. These agencies regularly report data to SBA on their awards. To merge the SBA data with the awards data, we used analytical software to match the observations in the two sources on one or more shared data elements, including award ID, company name, award date, dollars, and program phase. Using this method we were able to successfully match approximately 91 percent of the observations in our award timeliness data with SBA's data. We dropped from our data the remaining 9 percent of observations which were unmatched, after verifying that the unmatched records were not overrepresented in any award year or program phase.

The resulting dataset contained observations for 4,824 Air Force SBIR/STTR awards in FY 2016 through 2020, which we analyzed for trends, as described below, in open topics and conventional awards. Because our analyses use data from different sources, our results differed from other published sources, as discussed earlier in this report. We took additional steps to assess data reliability, including checking a random non-generalizable selection of 17 awards in the dataset against award files obtained from Air Force. Except for the data element on

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<sup>2</sup>See GAO, *Small Business Research Programs: Many Agencies Took Longer to Issue Small Business Awards than Recommended*, [GAO-19-620](#) (Washington, D.C.: Sept. 26, 2019); GAO, *Small Business Research Programs: Many Agencies' Award Issuances Are Not Timely; Some Practices May Improve Timeliness*, [GAO-20-693](#) (Washington, D.C.: Sept. 30, 2020); and GAO, *Small Business Research Programs: Agencies Should Further Improve Award Timeliness*, [GAO-22-104677](#) (Washington, D.C.: Oct. 14, 2021).

business size (number of employees), we found the data to be sufficiently reliable for our purposes in this report.

*Identification of open topics and conventional SBIR/STTR awards.*

Awards issued under Air Force’s open topics or conventional SBIR/STTR awards process correspond to unique topic codes published in SBIR or STTR solicitations. We obtained from Air Force a list of topic codes used to identify open topics awards. Using analytical software, we designated awards in our dataset as “open topics,” if the topic code matched an open topics code in the list; all other awards were designated as “conventional.” We also identified a special type of conventional awards, known as “pitch day” awards.

*Award year, program phase, and dollars awarded.* With open topics and conventional awards now identified, we analyzed the dataset for trends in the frequencies of these awards and dollars awarded by year and program phase. We calculated the award year as the fiscal year of the award date. Dollars awarded reflected the base and all options value of the awards.

*Award issuance time.* We calculated the award issuance time as the number of days between the solicitation close date and the issuance date of the award. For our prior reports on SBIR/STTR award timeliness, we collected data from Air Force and other agencies on the issuance date of their SBIR and STTR awards, which we defined as the date in which the agency and the company agreed to the award document. We reported on the extent to which the agencies’ award issuance times were within the 180 days recommended by SBA.

*Geographic dispersion.* To determine geographic dispersion of SBIR/STTR awards, we used software to calculate the number of unique zip codes for the open topics and conventional awards in our dataset and to plot the spatial centroid of each award zip codes on a base map. Using these award zip code locations, we created a density shading layer by estimating the probability density function of the award points. Mapping the awards allowed us to assess the dispersion of open topics and conventional awards, including identifying any geographic concentrations. However, it depicts descriptive information on concentrations of awards and does not identify statistically significant clusters of awards. In addition, some of the zip codes may not correspond with the physical location of the SBIR- or STTR-funded work, for example, if a company gave a different location, such as a mailing address, in its SBIR/STTR application. Furthermore, we excluded a small fraction of awards

(approximately 1.4 percent) with missing or erroneous zip codes from the analysis.

*Participation by women-owned small businesses or disadvantaged businesses.* We calculated participation rates for women-owned small businesses, socially and economically disadvantaged businesses, and businesses located in historically underutilized business districts, or HUBZones. Regression analysis was used to estimate the statistical significance associated with differences in these participations rates for open versus conventional awards.

*Business size (number of employees).* We were unable to report on business size. Hundreds of observations for this data element were missing or reported a value of zero employees. According to SBA's documentation for SBIR.gov, where we obtained the data on business size, number of employees is an optional data element for agencies that report data to SBA. Also according to the SBIR.gov documentation, zero is within the acceptable range of values for number of employees, which can range from zero to 500. Nonetheless, we were unable to reliably interpret a missing value or value of zero employees. As a result, we determined that the data element for number of employees was not sufficiently reliable for our purposes and, therefore, not reportable.

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## Analysis of Federal Contracting Data

To assess the extent to which Air Force's open topics and conventional awards processes attracted companies new to Air Force or federal contracting, we analyzed contracting data from the Federal Procurement Data System—Next Generation (FPDS-NG). FPDS-NG includes data on all reportable federal prime contracts. To identify all federal contracts awarded to companies that received Air Force SBIR or STTR awards in FY 2016 through 2020, we matched a unique company identifier in our dataset to contracts in FPDS-NG. We achieved an approximately 93 percent match rate. To ensure a manageable scope, we limited our analysis of FPDS-NG to contracts awarded in FY 2011 through 2020. We used software to count the companies' prior federal contracts in FPDS-NG with award dates between October 1, 2010, and the date of the company's first Air Force SBIR or STTR award in FY 2016 through 2020.

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## Examination of SBIR/STTR Award Files and Awardee Interviews

To address the provision to report on technology readiness levels (TRL) of Air Force SBIR/STTR awards, we examined proposals, contracts, and other award documentation. We determined we would be unable to efficiently measure awards' entry and exit TRLs.

Instead, we examined a random, non-generalizable selection of 17 SBIR/STTR award files for evidence of similarities or differences in the starting maturity of key technologies developed, or proposed for development, during the awards. The 17 awards included a selection of open topics and conventional Phase I and Phase II awards from fiscal years 2019 and 2020.

In addition, we contacted the 17 companies in our non-generalizable selection for an interview. We interviewed representatives from the 12 companies that responded about their experience with Air Force's SBIR/STTR process.

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## Other Analysis, Document Review, and Interviews

In addition, we conducted the following other analysis, document review, and interviews:

*Analysis of SBIR/STTR funding by Air Force missions.* Air Force provided us an analysis of the dollars awarded in FY 2016 through 2020 for its Phase II open topics and conventional awards for 25 technology sectors and 12 Air Force service core functions. As described in appendix II, we conducted further analysis of this information to identify Air Force's allocations of its SBIR/STTR funding for Air Force missions, as defined by the technology sectors and service core functions. See appendix II for more information.

*Commercialization of SBIR/STTR technologies.* We attempted to match potential Phase III contracts in FPDS-NG to our Air Force SBIR/STTR award data for FY 2018 through 2021 but were unsuccessful in reliably matching potential Phase III contracts to their SBIR/STTR awards. We used company identifiers, award dates, research titles and abstracts, and other data fields to match subsequent contracts to Phase II SBIR/STTR awards. Although the process turned up many likely matches by company identifier, limitations in FPDS-NG's descriptions of the technologies made

it difficult or impossible to systematically link SBIR/STTR awards with Phase III contracts.

*Review of open topics evaluations.* We reviewed the two published evaluations of the effectiveness of Air Force’s open topics process—Air Force’s *AFVentures FY18-20 Impact Report* and an April 2021 study by outside researchers and a former director of the office that administers Air Force’s open topics awards process.<sup>3</sup> We also interviewed Air Force officials involved in developing the 2021 impact report and two of the authors of the April 2021 study.

Other document review and interviews. We reviewed other documents describing Air Force’s open topics or conventional SBIR/STTR awards processes, including correspondence about the open topics process, budget requests, briefings, training modules for open topics proposal evaluators, SBIR and STTR solicitations, and other documents. We also examined studies of the Air Force, Navy, and DOD SBIR/STTR programs.<sup>4</sup> We interviewed Air Force SBIR/STTR officials about the key similarities and differences between the open topics and conventional awards process. We also interviewed Air Force officials and other DOD officials from the Office of the Under Secretary of Defense for Research and Engineering about the tracking of technology commercialization of SBIR/STTR Phase I and Phase II awards.

We conducted this performance audit from May 2021 to July 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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<sup>3</sup>Air Force, *AFVentures FY18-20 Impact Report*. (2021)

Sabrina T. Howell, Jason Rathje, John Van Reenen and Jun Wong, *Opening up Military Innovation: Causal Effects of ‘Bottom-up’ Reforms to U.S. Defense Research*, National Bureau of Economic Research (NBER) Working Paper No. 28700 (pre-publication draft, Nov. 26, 2020; published, Apr. 2021; updated Aug. 2021).

<sup>4</sup>TechLink, *National Economic Impacts from the Air Force SBIR/STTR Program, 2000-2013* (2015); *National Economic Impacts from the Navy SBIR/STTR Program, 2000-2013* (2016); *National Economic Impacts from the DOD SBIR/STTR Program, 1995-2018* (2019).



## Appendix II: Allocation of Phase II SBIR and STTR Award Funding across Technology Sectors and Service Core Functions

The House report requesting our review of Air Force's open topics awards process for its SBIR and STTR awards included a provision for us to report on SBIR/STTR funding received by Air Force missions.<sup>1</sup> Air Force provided an analysis containing two different cross-sections of its SBIR/STTR funding, which it allocated across 25 technology sectors and 12 Air Force service core functions.

Eleven of the 25 Air Force technology sectors align with DOD's research and engineering modernization priorities.<sup>2</sup> The 12 service core functions generally correspond to six of Air Force's nine major commands and U.S. Space Force.<sup>3</sup> The core functions provide a more detailed breakdown of the Air Force major commands and, in particular, the Air Combat

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<sup>1</sup>H. Rpt. 116-442 of the Committee on Armed Services, which accompanies the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283 (Jan. 1, 2021). The House report included a provision for GAO to review and assess the Air Force's Ventures process and SBIR/STTR effort, including, among other provisions, by providing trend analysis for no less than five years on which Air Force missions are receiving SBIR funding.

<sup>2</sup>The Office of the Under Secretary of Defense for Research & Engineering articulated 11 modernization priorities, including (1) artificial intelligence; (2) biotechnology; (3) autonomy; (4) cyber; (5) directed energy; (6) fully networked command, control, and communications; (7) microelectronics; (8) quantum science; (9) hypersonic weapons; (10) space; and (11) 5G.

<sup>3</sup>Generally, six of the 12 service core functions correspond to primary missions of Air Force's Air Combat Command (ACC)—one of the nine Air Force major commands. The six ACC core functions include (1) air superiority; (2) global precision attack; (3) personnel recovery; (4) cyberspace superiority; (5) command and control; and (6) global integrated intelligence, surveillance, and reconnaissance. The remaining six out of the 12 service core functions generally correspond to the following major commands and U.S. Space Force: (7) the education and training core function corresponds to the Air Education and Training Command; (8) the agile combat support core function to the Air Force Materiel Command; (9) special operations to the Air Force Special Operations Command; (10) space superiority to U.S. Space Force (formerly, Air Force Space Command); (11) rapid global mobility to the Air Mobility Command; and (12) nuclear deterrence operations to the Air Force Global Strike Command.

**Appendix II: Allocation of Phase II SBIR and STTR Award Funding across Technology Sectors and Service Core Functions**

Command, which is responsible for providing combat air power and command, control, communications, and intelligence systems, among other missions.

Table 5 and Table 6, respectively, present Air Force’s allocations of its SBIR/STTR funding across the 25 technology sectors and 12 service core functions. These allocations include funding for Phase II awards in fiscal years 2016 through 2020 with a further breakout by open topics or conventional awards. In addition, the SBIR/STTR award dollars in the analysis included the initial award amount, as well as any award modifications, extensions, and private matching funds. Also, funding information for open topics awards was available for only two of the years, FY 2019 and 2020, when Air Force made open topics Phase II awards. As a result, we are reporting percentages and rank-order rather than raw dollar amounts for the technology sectors and service core functions.

**Table 5: Funding for Air Force SBIR/STTR Phase II Awards, Fiscal Years 2016 through 2020, across 25 Air Force Technology Sectors**

Air Force technology sector	Open topics awards <sup>a</sup>		Conventional awards	
	Percentage	Rank	Percentage	Rank
5G communications	0.76	21	0.40	25
Advanced manufacturing	2.13	13	2.32	16
Artificial intelligence and machine learning	12.83	2	4.23	10
Augmented/virtual reality	9.97	4	1.61	22
Autonomy	8.73	5	5.60	5
Biotechnology	5.29	8	1.13	23
Coatings and platings	0.82	18	4.65	8
Cyber operations and security	8.41	6	4.69	7
Directed energy	0.44	23	3.81	11
Enterprise/business management	6.50	7	2.11	18
Fully networked command, control, and communications	10.32	3	9.73	2
Hypersonic weapons	1.34	16	8.18	3
Microelectronics	1.46	15	4.63	9
Modeling and simulation	0.55	22	3.11	15
Munitions	0.34	24	3.74	13
Nondestructive inspection and evaluation	0.80	19	3.11	14
Power and propulsion	2.22	12	3.76	12
Quantum science	0.78	20	0.72	24

**Appendix II: Allocation of Phase II SBIR and STTR Award Funding across Technology Sectors and Service Core Functions**

Safety	1.76	14	1.31	21
Sensing	2.38	11	7.17	4
Space technologies	13.73	1	13.56	1
Sustainment	3.78	9	5.56	6
Thermal	0.31	25	1.75	19
Training	3.32	10	1.47	20
Weather	1.09	17	2.12	17

Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) award data. | GAO-22-105223

<sup>a</sup>Air Force only awarded Phase II open topics awards in fiscal years 2019 and 2020.

**Table 6: Funding for Air Force SBIR/STTR Phase II Awards, Fiscal Years 2016 through 2020, across 12 Air Force Service Core Functions**

Air Force service core function	Open topics awards <sup>a</sup>		Conventional awards	
	Percentage	Rank	Percentage	Rank
Agile Combat Support	6.29	10	7.56	7
Air Superiority	13.28	1	13.22	2
Command and Control	8.45	5	8.74	5
Cyberspace Superiority	8.32	7	6.37	10
Education & Training	3.95	12	2.70	12
Global Integrated ISR	6.01	11	6.63	9
Global Precision Attack	9.94	4	8.86	4
Nuclear Deterrence Operations	7.08	9	4.48	11
Personnel Recovery Operations	7.52	8	7.44	8
Rapid Global Mobility	9.52	3	11.41	3
Space Superiority	11.69	2	13.91	1
Special Operations	8.40	6	8.68	6

Source: GAO analysis of Air Force Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) award data. | GAO-22-105223

<sup>a</sup>Air Force only awarded Phase II open topics awards in fiscal years 2019 and 2020.

## Appendix III: Comments from the Department of Defense



DEPARTMENT OF THE AIR FORCE  
WASHINGTON, DC

OFFICE OF THE ASSISTANT SECRETARY

MEMORANDUM FOR U.S. GOVERNMENT ACCOUNTABILITY OFFICE

FROM: SAF/AQ  
1120 Air Force Pentagon  
Washington, DC 20330

SUBJECT: Department of Defense Response to GAO Draft Report, "Small Business Research: Air Force had success with new awards process, but improvements needed to better assess effectiveness" (Project Code 105223)

1. This is the Department of Defense (DoD) response to the GAO Draft Report, "Small Business Research: Air Force had success with new awards process, but improvements needed to better assess effectiveness" (Project Code 105223). The DoD concurs with recommendation 1 and partially concurs with recommendation 2.

2. Attached is the DAF proposed response to the subject report recommendations. The SAF/AQ point of contact is Mr. Ben Phillips, SAF/AQR, (812) 212-3251, or via email at [benjamin.phillips.5@us.af.mil](mailto:benjamin.phillips.5@us.af.mil).

A handwritten signature in cursive script that reads "Darlene J. Costello".

DARLENE J. COSTELLO  
Principal Deputy Assistant Secretary of the Air  
Force (Acquisition, Technology & Logistics)

Attachment:

1. Department of Defense Comments to the GAO Recommendations

GAO DRAFT REPORT DATED MAY 18, 2022  
GAO-22-105223 (GAO CODE 105223)

“SMALL BUSINESS RESEARCH: AIR FORCE HAD SUCCESS WITH NEW AWARDS  
PROCESS, BUT IMPROVEMENTS NEEDED TO BETTER ASSESS  
EFFECTIVENESS”

DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATION

**RECOMMENDATION 1:** The Secretary of the Air Force should ensure that public reports on the effectiveness of the open topics SBIR/STTR process include information on participation by women-owned small businesses.

**DoD RESPONSE:** Concur.

**RECOMMENDATION 2:** The Secretary of the Air Force should ensure that Air Force verifies that its data on company size and participation by disadvantaged businesses in the open topics process is current and reliable for monitoring the process’s effectiveness in attracting such businesses and smaller companies

**DoD RESPONSE:** Partially concur. The DAF uses government provided data from SAM.gov to collect data on company size and participation by small disadvantaged businesses (SDBs), which includes SDB self-certifications subject to SBA protests, as well as SBA-approved certifications for any Section 8(a) SDBs. Notably, as of 30 Sep 2008, SBA no longer certifies non-8(a) SDB firms’ size or status. The DAF does not agree with the recommendation to create a new process to re-verify the accuracy of SDB certifications in SAM.gov or otherwise when the SBA deemed SDB certifications unnecessary. The DAF’s role in SDB size or status challenges is limited to referring issues to the SBA in certain narrow situations contemplated by existing regulations (e.g., FAR 19.304, FAR 19.305, and 19.813). These regulations do not contemplate SDB data re-verification process at the buying agency level.

The President’s Administration places strong priority on measuring and expanding SDB participation in Federal acquisitions, and on reducing entry barriers for SDBs. The DAF will ensure its internal processes provide current and reliable data for monitoring effectiveness in attracting SDBs to DAF SBIR/STTR, consistent with EO 13985 and the President’s SDB participation growth initiatives, as further implemented by any OMB, SBA, and OSD guidance.

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## Text of Appendix III: Comments from the Department of Defense

DEPARTMENT OF THE AIR FORCE

OFFICE OF THE ASSISTANT SECRETARY

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SAF/AQ

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DARLENEJ.COSTELLO  
Principal Deputy Assistant Secretary of the Air  
Force (Acquisition, Technology & Logistics)

Attachment:

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## Appendix IV: GAO Contact and Staff Acknowledgments

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### GAO Contact

Candice N. Wright, (202) 512-6888 or [wrightc@gao.gov](mailto:wrightc@gao.gov).

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### Staff Acknowledgments

In addition to the contact named above, Tind Shepper Ryen (Assistant Director), Jeff Rueckhaus (Analyst-in-charge), Maxwell Kaufman, Joanna Kim, and Alyssa Skarbek made key contributions to this report. Also contributing were Nora Adkins, Brandon Booth, Jenny Chanley, Eric Charles, Louise Fickel, Ryan Han, Robert Letzler, Chi Mai, Alec McQuilkin, and Jack Wang.



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