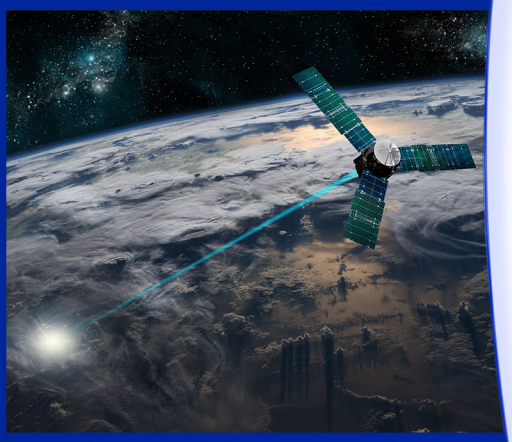


DEFENSE RAPID INNOVATION FUND

An Assessment of RIF Effectiveness FY 2011-2016

MAJOR RESULTS

From Defense Rapid Innovation Fund, Assessment of Program Effectiveness

2011-2016

DoD's investment of nearly $1.4 billion in RIF funding, invested through 670 separate awards, resulted in:

57%
RIF awards transitioned or expected to transition to Military use

$2.4 Billion
Sales of products or services to the Military

60%
or more RIF awards derived from SBIR/STTRs

$410 Million
Sales of products or services to non-Military customers

587 or 88%
of RIF awards were to small businesses, totalling $1.21 billion in funding

96%
Study Response Rate

Shutterstock.com / LauGSmith

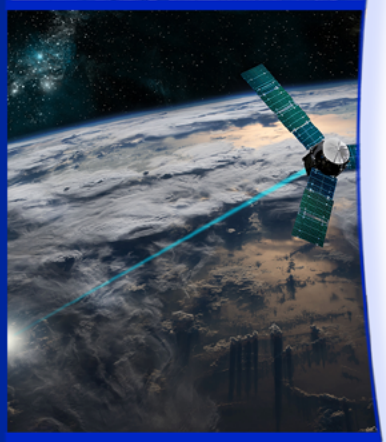


Table of Contents

Photos, top to bottom: March Air Reserve Base, CA, Photo by Senior Airman Clayton Wear; shutterstock.com/Marc Ward; Mediterranean Sea, Photo by Petty Officer 1st Class Michael DiMestico; shutterstock.com/Alexyz3d; U.S. Army Reserve warrant officer candidate Sofia Olds, Photo by Major Wayne Clyne

Table of Figures

1. Executive Summary

The study detailed in this report supports the requirements of the Fiscal Year (FY) 2020 National Defense Authorization Act (NDAA) which mandates an assessment of the effectiveness of the Rapid Innovation Fund (RIF) in achieving its objectives: stimulating innovative technologies, reducing acquisition or lifecycle costs, addressing technical risk, and improving the timeliness and thoroughness of test and evaluation outcomes. Study results provide metrics requested in the FY 2020 NDAA on the number of awards and percentage of RIF funding allocated to projects derived from Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) efforts, as well as quantify outcomes in terms of transition to Defense use and acquisition.

The findings contained in this report resulted from a survey of 479 recipients of nearly $1.4 billion in RIF funding, invested through 670 separate awards in response to FY 2011 through FY 2016 RIF Broad Agency Announcements (BAAs). Surveyed recipients provided

comprehensive information on the results of 96% of all RIF awards. RIF award data listed 677 awards to 485 different companies and other organizations, but the survey found that seven of these, including one to a company with multiple RIF awards, were never funded for various reasons. Several RIF awards were split among more than one recipient, or even subawarded to multiple performers. In such cases, only one organization was counted as the recipient.

Major Results

57%
RIF AWARDS TRANSITIONED OR EXPECTED TO TRANSITION TO MILITARY USE

$2.4 Billion
SALES OF PRODUCTS OR SERVICES TO THE MILITARY

$410 Million
SALES OF PRODUCTS OR SERVICES TO NON-MILITARY CUSTOMERS

60%
OR MORE RIF AWARDS DERIVED FROM SBIR/STTRS

587 or 88%
OF RIF AWARDS WERE TO SMALL BUSINESSES, TOTALLING $1.21 BILLION IN FUNDING

96%
STUDY RESPONSE RATE

Major results of the study include:

Small Business and SBIR/STTR

- 587 (88%) out of 670 RIF awards were made to small businesses, totaling $1.21 billion (89% of RIF funds).
- 399 (60%) were verified as being derived from prior SBIR/STTR awards, totaling $846 million (62% of RIF funds). This number could be as high as 478 RIF awards (71%), totaling $998 million (73% of RIF funds).

Transition

- 379 (57%) out of 670 RIF awards have transitioned or are expected to transition in the near future to Military use. These include:
    - 208 (31%) already transitioned;
    - 171 (26%) expected to transition.
- 215 (54%) out of 399 SBIR/STTR-derived awards have transitioned or are expected to transition in the near future to Military use. These include:
    - 125 (31%) already transitioned;
    - 90 (23%) expected to transition.

Military and Commercial Sales

- 178 (27%) out of 670 RIF awards resulted in $2.4 billion in sales of products or services to the Military to date, which is nearly double the initial RIF investment.
- 75 (11%) resulted in $410 million in sales of products or services to non-Department of Defense (DoD) customers, including other government agencies or law enforcement.

RIF Objectives

- 143 (21% overall and 69% of transitioned awards) resulted in reduced acquisition or lifecycle costs.
- 164 (24% overall and 79% of transitioned awards) resulted in reduced technical risk for the DoD.
- 103 (15% overall and 50% of transitioned awards) improved the timeliness or thoroughness of DoD test and evaluation outcomes.

In addition to the above findings, this report includes project results, innovation types, and Warfighter impacts broken down by category. The report also delineates which DoD Components are currently using the technologies developed through RIF awards.

A detailed appendix includes short, company-approved technical summaries providing examples of how RIF awards met the goals of the program, contributed to specific programs of record, reduced costs, and addressed the modernization priorities outlined in the National Defense Strategy.

2. Background

a. Rapid Innovation Fund Overview

The Defense Research and Development Rapid Innovation Program was established in Section 1073 of the Fiscal Year (FY) 2011 National Defense Authorization Act (NDAA). The program was subsequently redesignated as the Defense Rapid Innovation Fund (RIF) and is administered by the Under Secretary of Defense for Research and Engineering (USD(R&E)) Small Business and Technology Partnerships (SBTP). With a preference for small businesses, it was designed as a merit-based system to accelerate the fielding of innovative technologies into Military systems.[1]

For the initial FY 2011 Broad Agency Announcement (BAA), $439 million was appropriated for the program. For FYs 2012 through 2019, the appropriated amounts ranged from $175 million to $250 million. RIF was reauthorized in the FY 2017 NDAA as a permanent program. No funding was appropriated for FY 2020.

1 https://business.defense.gov/Portals/57/Documents/RIF.pdf

The RIF is designed to help rapidly transition innovative technologies to U.S. Military use, especially those developed under the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) program and close to transition. RIF awards during the period of this study were limited to $3 million, with a project duration of no longer than 24 months.[2] The two-step proposal process is accessible and highly appealing to small businesses. It begins with a brief white paper and quad chart addressing specified Defense needs. Applicants selected to subsequently submit a full proposal have a strong chance of winning which minimizes time-consuming proposal development efforts. While selection preference is given to small businesses, awards to others, including foreign participants, are allowed, but only after the approval authority deems the offer superior to one received from a small business.[3] In this way, the RIF ensures that critical Defense needs can be met through a broad, competitive process.

shutterstock.com/Peshkova

The RIF was established after a series of efforts dating back to at least 1996 to help speed the acquisition and fielding of needed innovative technologies developed under the SBIR/STTR program. Recommendations were repeatedly made to set aside dedicated Phase III funding. Prior to the FY 2011 NDAA, reports highlighting the issue included the 2007 "Kubricky Report,"[4] a 2007 RAND Corporation study of Department of Defense (DoD) SBIR,[5] and a landmark 2008 National Academy of Sciences study.[6] When the U.S. House Committee on Appropriations announced in 2010 that it would no longer approve requests for earmarks directed to for-profit entities, it also announced that "a program will be established to provide an opportunity for businesses—especially small start-up companies with no inside Pentagon connections—to present their good ideas and products to the Defense Department. Businesses will be able to apply, but the Defense Department, not Congress, will choose which for-profit

2 Program changes implemented in the FY 2020 NDAA will now allow some awards of up to $6 million, and some exceptions to the 24-month project duration limit.

3 In alignment with the second pillar of the 2018 National Defense Strategy (NDS), to "Strengthen Alliances and Attract New Partners," foreign RIF award recipients have included a small number of firms from Canada, the UK, and Norway.

4 Office of the Secretary of Defense (OSD), DoD Report to Congress on Technology Transition, July 2007

5 Held, Bruce; Evaluation and Recommendations for Improvement of the DoD SBIR Program; RAND Corp; 7 December 2007

6 National Research Council; An Assessment of the SBIR Program; 2008; Sec. 5.9.8

projects will be funded."[7] The ensuing legislation created the Rapid Innovation Program, now RIF, and ensured that the DoD would have clear authority to select the best projects for its urgent needs without being restricted solely to SBIR/STTR-derived technology or small business applicants.

In the years since, hundreds of RIF awards have been issued, allocating over $2 billion ($1.4 billion for the years of this study) among companies, educational institutions, and non-profit entities across the United States.

b. Fiscal Year 2020 National Defense Authorization Act Report Requirement

TechLink was commissioned by the DoD to conduct this study in support of a reporting requirement in the FY 2020 NDAA. The NDAA language is as follows:

> SEC. 878. MODIFICATION TO THE DEFENSE RESEARCH AND DEVELOPMENT RAPID INNOVATION PROGRAM.
>
> (b) REPORT .—Not later than 180 days after the date of the enactment of this Act, the Secretary of Defense shall submit to the congressional defense committees a report on the program established under section 2359a(a) of title 10, United States Code (commonly known as the "Defense Research and Development Rapid Innovation Program"), which shall include—
>
> (1) with respect to the two fiscal years preceding the submission of the report—
>
> (A) a description of the total number of proposals funded under the program;
>
> (B) the percent of funds made available under the program for phase II Small Business Innovation Research Program projects (as defined under section 9 of the Small Business Act (15 U.S.C. 638)); and
>
> (C) a list of phase II Small Business Innovation Research Program projects that received funding under the program that were included in major defense acquisition programs (as defined in section 2430 of title 10, United States Code) and other defense acquisition programs that meet critical national security needs; and
>
> (2) an assessment on the effectiveness of the program in stimulating innovative technologies, reducing acquisition or lifecycle costs, addressing technical risk, and improving the timeliness and thoroughness of test and evaluation outcomes.

7 David R. Obey, Chairman, U.S. House of Representatives, Committee on Appropriations, Press Release "Appropriations Committee Bans For-Profit Earmarks," 10 March 2010

3. Purpose of Study

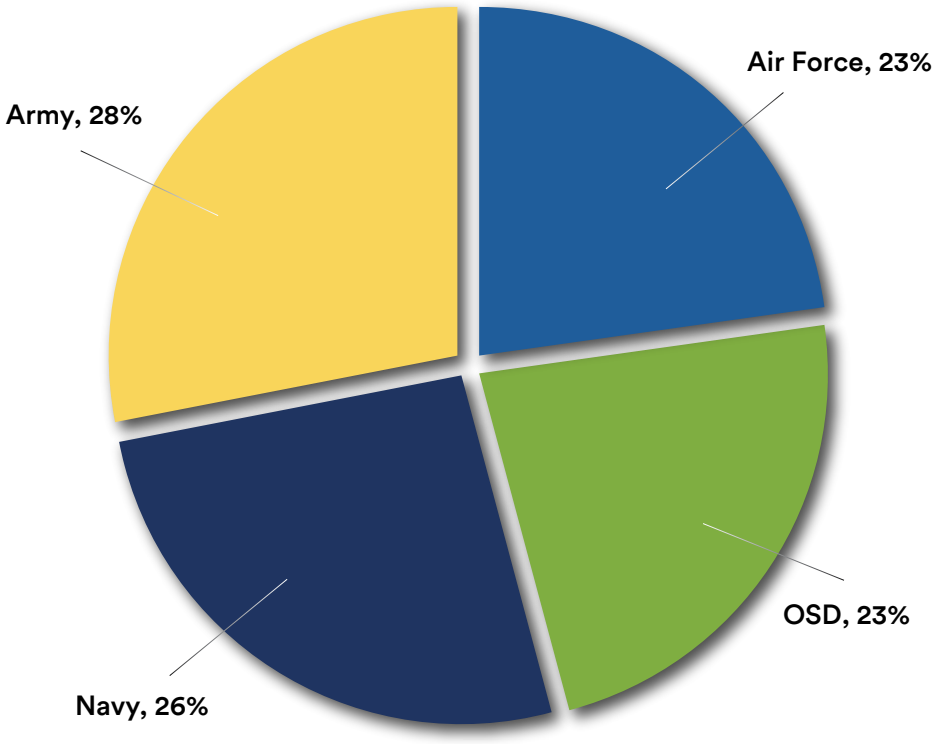
a. Rapid Innovation Fund Study Aim

This study enables RIF program management to evaluate RIF transition activities and assess program effectiveness, specifically in support of the Congressional directive in the FY 2020 NDAA. Both the study and this report are structured around a survey involving all recipients of RIF awards resulting from RIF BAAs from FY 2011 through FY 2016. During this period, 479 companies received a total of $1.4 billion through 670 awards. Participating respondents provided outcomes for 96% of all such RIF awards.[8]

8 A previous report conducted by the Government Accountability Office reviewed a much smaller sample of DoD RIF awards: Government Accountability Office (GAO) Report to the Committee on Armed Services, U.S. Senate. "The DoD Rapid Innovation Program: Some Technologies Have Transitioned to Military Users, but Steps Can Be Taken to Improve Program Metrics and Outcomes," May 2015

Figure 1 illustrates the distribution of these RIF awards by the issuing DoD Component. The percentage of these awards was fairly evenly distributed by major DoD Component: Army (28%), Navy (26%), and Air Force (23%), and other DoD Components under the Office of the Secretary of Defense (OSD, 23%).

Figure 1



Percentage of RIF awards by DoD Component FY 2011-2016

b. TechLink Role and Research Team

To conduct this study, the RIF partnered with TechLink—a U.S. Department of Defense Partnership Intermediary based at Montana State University. Since 1999, TechLink has served as DoD's primary national Partnership Intermediary, helping to develop technology transfer partnerships between DoD laboratories and U.S. industry. TechLink's primary focus is

facilitating the transfer of patented inventions and other intellectual property from DoD labs to U.S. companies through licensing agreements. These agreements enable companies to develop, manufacture, and sell new products and services using DoD inventions. TechLink currently brokers or facilitates over 70% of all DoD patent license agreements (PLAs) with industry. TechLink's role in DoD technology transfer also supports the development of Cooperative Research and Development Agreements (CRADAs) and other agreements between DoD labs and industry and/or universities, often in support of PLAs.

Additionally, TechLink has long supported the transfer of innovative technologies from industry to Defense utilization by supporting small companies in underserved states through the DoD SBIR/STTR Programs, with a focus on transition to Military use. This support of technology transfer into DoD has regularly included working with RIF program applicants and other DoD research and development (R&D) and acquisition programs. TechLink clients have received over $250 million in SBIR/STTR Phase I, II, and III funding as a direct result of this support.

TechLink has also conducted over a dozen studies to evaluate the economic impacts of various federal initiatives. The first such TechLink study, in 2009, surveyed clients to estimate the total economic impacts of TechLink's support to DoD. The results found a total economic impact of $729 million. Follow-on studies in 2012 and 2019 found total economic impacts of $2.94 billion and $6.9 billion, respectively. TechLink has also conducted similar economic impact studies at the express request of DoD, evaluating the economic impacts of DoD PLAs, CRADAs, and the SBIR/STTR programs for the Air Force, Navy, and all of DoD. These studies have provided important and useful estimates of the economic benefits of these programs to the national economy and the U.S. Defense mission.[9] TechLink's follow-up success stories on outstanding individual projects have highlighted the additional value conveyed to the U.S. Warfighter and the general public.

TechLink staff contributing to this study include Ray Friesenhahn, Joe Hutton, Jessica Kaplin, Jeff Peterson, Matt Rognlie, Chris VanBockle, Dr. Michael Wallner, and Michelle Zook.

9 For more information, see *www.techlinkcenter.org*

4. Methodologies

The study was conducted in four phases: methodological planning, data preparation, survey, and data analysis. The study was initiated in October 2019 and was completed March 2020.

a. Methodological Planning (October 2019)

The *methodological planning* phase began in October 2019 with numerous discussions between TechLink and the RIF. Adhering to the NDAA, planning involved identifying the ultimate goals of the study and developing survey questions which allowed for those goals to be met.

b. Data Preparation (October 2019 – November 2019)

The *data preparation* phase was carried out in October 2019 and November 2019. RIF personnel delivered data to

TechLink in two files. The first contained partially incomplete descriptive data and select contact information for all RIF awards resulting from the FY 2011-FY 2013 RIF BAAs. The second included data for those awards resulting from the FY 2014-FY 2016 RIF BAAs. TechLink staff spent several weeks reviewing each dataset and cross-referencing information with federal databases such as the Federal Procurement Data System (FPDS) and DoD SBIR/STTR award databases to correct errors and compile missing data.

The initial lists contained 677 RIF awards. Through both the initial research/data cleanup phase and the survey process, seven awards were found to have never been funded.[10] The final set included 670 RIF awards to 479 separate companies or organizations.[11] A total of 111 of these awardees received multiple RIF awards, with the most active company receiving a total of 11 awards.

Photo courtesy Flir Systems, Inc.

c. Survey (October 2019 – February 2020)

The *survey* began in October 2019 and lasted until February 2020. Survey respondents were asked a series of questions focused on the strategic, Military, and financial outcomes of their RIF awards. Researchers stressed TechLink's policy of protecting proprietary data and only sharing outcomes in the aggregate. A key goal of this survey was to evaluate RIF projects beyond completion, with a specific focus on how they positively impacted acquisition programs or the U.S. Warfighter. This research is partially related to shortcomings identified by the Government Accountability Office (GAO) RIF Report.

TechLink's researchers attempted to contact the recipients of all 670 funded RIF awards. At first contact, respondents were guaranteed anonymity of their survey responses and assured that only aggregated financial and program information would be reported. An official signed letter from the RIF Director (Appendix 1) validated the authenticity of the study and confirmed the guarantee of anonymity. Exceptions to this anonymity were voluntary opportunities to participate in success stories or approve brief technical summaries for a more detailed appendix to the study (Appendix 2).

10 In all seven cases, no award contract could be found in public records, and companies then confirmed no RIF funding was received. For one, the listed award was an apparent duplicate of another award to a different company; another stated they applied for RIF but were not selected for an award; one company received funding from a different source while awaiting RIF funding, and several awards were canceled or not funded for reasons not described.

11 The organizations participating in the RIF include commercial entities, not-for-profits, and educational institutions. For brevity, participating organizations are generally referred to as "companies."

The information collected was stored in TechLink's proprietary and secure database. The team held weekly meetings to address specific challenges and collaborate on particularly difficult-to-find recipients. TechLink analysts reviewed completed surveys to help ensure their accuracy.

The research team reached out through multiple communication channels, supplementing phone calls and emails with social media outlets such as LinkedIn. In some cases, the RIF-developed technology was owned by a new organization, such as an acquiring company, necessitating additional follow-up communications. Researchers sometimes contacted more than a dozen people before reaching someone qualified to answer the survey.

d. Data Analysis (February 2020 – March 2020)

The *data analysis* phase began upon completion of the survey in February 2020. TechLink economic analysts compiled all survey responses and generated descriptive statistics when possible. Analysts and individual researchers reviewed any apparent outliers to ensure their accuracy.

The data analysis process involved sorting relevant responses to provide program-wide answers to each survey question. The methodology employed a census sample of the data that was utilized for the FY 2011-FY 2016 RIF review.

shutterstock/Gorodenkoff

The answers to open-ended questions were analyzed and, with company consent, detailed in a series of brief technical summaries which provide anecdotal insights into how these projects integrate with and support the U.S. defense mission. This process was completed upon report delivery to RIF program management on March 31, 2020.

e. Survey Response

By the conclusion of the survey, 466 RIF recipients, representing 646 awards (96% of the total), had complied with the study. Of the original 479 recipients in the survey, only two companies refused to participate and 11 were unable to be contacted despite researchers' best efforts. As a result, the outcomes of 24 awards (4%) remain unknown.

The primary reasons for the study's high response rates are believed to be the following:

- *Clear communication about the purpose and legitimacy of the study*. Companies were informed that the study's purpose was to evaluate the RIF rather than any company's individual performance. Those that questioned the legitimacy of the study were sent an official letter provided and signed by the Director of the RIF (see Appendix 1). This letter explained the purpose, confidential nature, data aggregation, and importance of the study.
- *Strong assurance that company-specific information would be kept confidential*. Companies were assured that proprietary company data would not be shared with anyone—even RIF personnel. Without the assurance that all responses would be kept confidential, few companies would have been willing to divulge sales information. Additionally, the confidentiality assurance likely helped reduce response bias. For example, an unsuccessful company might hesitate to admit failure unless guaranteed anonymity.

  However, companies that indicated successful transition to Military use of their (unclassified) technologies were given the opportunity to be highlighted in publication-quality, professionally written success stories and to be included with a brief summary in an appendix emphasizing the effective transition of technologies to Military use. Qualifying companies approved short summaries of their projects, relating how each has been fielded by the Military. A team of professional writers was employed to develop more in-depth success stories suitable for publication. These stories will be publicly distributed at the discretion of the Office of the Secretary of Defense. Additionally, at least five transitioned RIF projects will be featured in short videos describing the technologies and their use by the Military.
- *Persistence by TechLink economic research specialists*. Initial contact information was not always available, and extensive online research was sometimes necessary. Some companies were contacted more than a dozen times by email or telephone in the attempt to reach the right person and obtain the necessary information.

5. Findings

a. Small Business Participation

The RIF was established with a small business preference, per 10 USC 2359a. To determine the extent of small business participation, TechLink analysts used online research tools to verify the business type and size of each listed RIF awardee *at the time of their award*, filling in missing data, and correcting misidentified listings. The final results showed that 587 out of 670 RIF awards, or 88%, were made to small businesses. The total RIF funding made to these small businesses was $1.21 billion, or 89% of all RIF funds.

b. Small Business Innovation Research/ Technology Transfer Origins

One catalyst for the RIF was the drive to establish a dedicated Phase III fund that could assist with the commercialization and Military utilization of DoD SBIR/STTR Phase II awards. While not limited to finding solutions exclusively from

SBIR/STTR-supported innovations, the intent was that a RIF award could often help accelerate the transition of a promising SBIR/STTR technology into the hands of the Warfighter. RIF funding could help SBIR/STTR firms bridge the so-called "Valley of Death" in which lack of appropriate Phase III funding was a limiting factor in transitioning SBIR/STTR technologies to Military acquisition programs.

Given the prominent role of SBIR/STTR in the creation and implementation of the RIF, as well as the importance of SBIR/STTR Phase III in federal law, the following questions were included in the survey:

Was this RIF award derived from an SBIR/STTR award?
If yes, was the RIF award formally designated as a Phase III?

1. Derivation from Prior Small Business Innovation Research/ Technology Transfer Award

Background: Award data provided by the RIF was often incomplete, not always showing which RIF awards were derived from SBIR/STTR awards. Respondents in the RIF survey may not have been employees of the firm at the time of the RIF application. Consequently, they may not have been familiar with the provenance of the RIF award and the company's SBIR/STTR history. For these reasons, a RIF award was recorded as being derived from a prior SBIR/STTR if it met one of the following criteria:

- A supporting prior SBIR/STTR was listed in the RIF award data;
- The respondent affirmed that the award derived from a prior SBIR/STTR;
- The RIF contract was listed as a SBIR/STTR Phase III in FPDS and the company had actually received a prior SBIR/STTR award that could be linked to the RIF award.

In multiple cases, either recipients or FPDS identified awards as SBIR/STTR-derived, despite the company not having any prior SBIR/STTR awards. In these cases, results were corrected.

Results: Of the 670 RIF awards over the six-year period, 399 (60%) were determined to have been derived from prior SBIR/STTR projects. This number includes eight RIF awards to larger firms or organizations as successors-in-interest to prior SBIR/STTR awards. Total RIF funding for these awards was $846 million (62% of all RIF funds for the period).

The 399 RIF awards found to have been derived from SBIR/STTR projects almost certainly underrepresent the reality. In comparing RIF awards to past SBIR/STTR awards for the same company, many firms with multiple DoD SBIR/STTR awards did not directly associate any

SBIR/STTR with their RIF awards. Furthermore, nearly 80% of companies with multiple RIF awards had prior DoD SBIR/STTR awards or had acquired SBIR/STTR firms, yet many of these attributed some, but not all, of their RIF awards to prior SBIR/STTR awards. This may have been due to their reluctance to claim a direct association to a specific prior SBIR/STTR award, even if their base technologies and capabilities were all developed under various SBIR/STTR awards.

If all RIF awards given to companies with prior DoD SBIR/STTR awards are considered SBIR/STTR-derived, the number could be as high as 478 (71% of the total). Together, these 478 awards totaled $998 million in funding (73% of all RIF funds for the period).

Of the 399 RIF awards reported to have derived from SBIR/STTR, 215 (54%) have transitioned, or are expected to transition, to Military use in the near future. One hundred twenty five (31%) have already transitioned to Military use.

ii. Designation as Phase III Small Business Innovation Research/ Technology Transfer Award

Background: A Phase III SBIR/STTR is defined as work that "derives from, extends, or completes an effort made under prior SBIR/STTR Funding Agreements"[12] and is funded with non-SBIR/STTR funds. An official Phase III designation extends valuable SBIR/STTR data rights and also provides preferences in related government contracts, including the right to receive sole-source funding agreements. Despite the importance and value of Phase III, it is poorly understood by many small businesses, as well as by many government Program Managers and Contracting Officers. Although FPDS may indicate Phase III status, this is not consistent. Also, Phase III may be designated as such on the contract, without being included in FPDS. Due to these issues, this study considers RIF awards as Phase III if they were listed as such in FPDS or in the survey. Awards were omitted from the Phase III count where the company had not received a prior SBIR/STTR award, despite a Phase III designation in FPDS.

Results: The FPDS database found that 156 RIF awards of the 670 total were designated as Phase III SBIR/STTRs. Four of these companies had no prior SBIR/STTR awards, leaving 152 actual SBIR/STTR Phase III awards in FPDS. In addition, 33 RIF awards not designated as such in FPDS were reported by respondents to be Phase III, for a total 185 RIF awards (28%) considered to be SBIR/STTR Phase III.

12 Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Program Policy Directive. Effective: May 2, 2019. Current and prior versions available at https://www.sbir.gov/about/about-sbir.

c. Transition Success

1. Transition to Military Use

During development of RIF survey questions, it was recognized that few respondents would understand in a consistent manner the term "transition" or "transition to Military use," as that usage is poorly defined and interpreted in various ways. The question of whether a product was "included in a major Defense acquisition program"[13] would be even less likely to be understood. The civilian respondents to this survey, especially small business principals and technologists, sometimes have little or no understanding of what constitutes a major acquisition program or if their resulting product was ultimately used by one. For these reasons, after much discussion, the question was formulated as follows, to provide the most definitive answers regarding transition to Military use and reduce possible confusion among respondents:

> Is the U.S. Military currently using the technology or innovation that resulted from this RIF contract?

Respondents answered "Yes" for 208 RIF awards (31% of the total). In addition, a follow-up question asking if the U.S. Military was *expecting* to use the RIF results in the near future was included. This question was necessary considering how recently some of the awards were completed. Adoption and acquisition of new advanced technologies by the Military is notoriously slow—even the DoD's definition for Advanced Technology Development (6.3) states, "Projects in this category should have the *goal* of moving out of S&T and into the acquisition process within 5 years."[14] The RIF's earliest awards would have been completed just six years prior to this survey (awards funded in September 2012 with 24-month duration), while awards from the FY 2016 RIF BAA included in this study would only have been completed a few months prior to the survey.

These considerations led to the follow-up question:

> If not, is the U.S. Military planning to or expected to use the resulting technology or innovation in the near future?

Respondents answered "Yes" for 171 of the not-yet-transitioned awards. This represents 37% of those not yet transitioned and 26% of the overall awards.

13 As defined in section 2430 of title 10, United States Code.

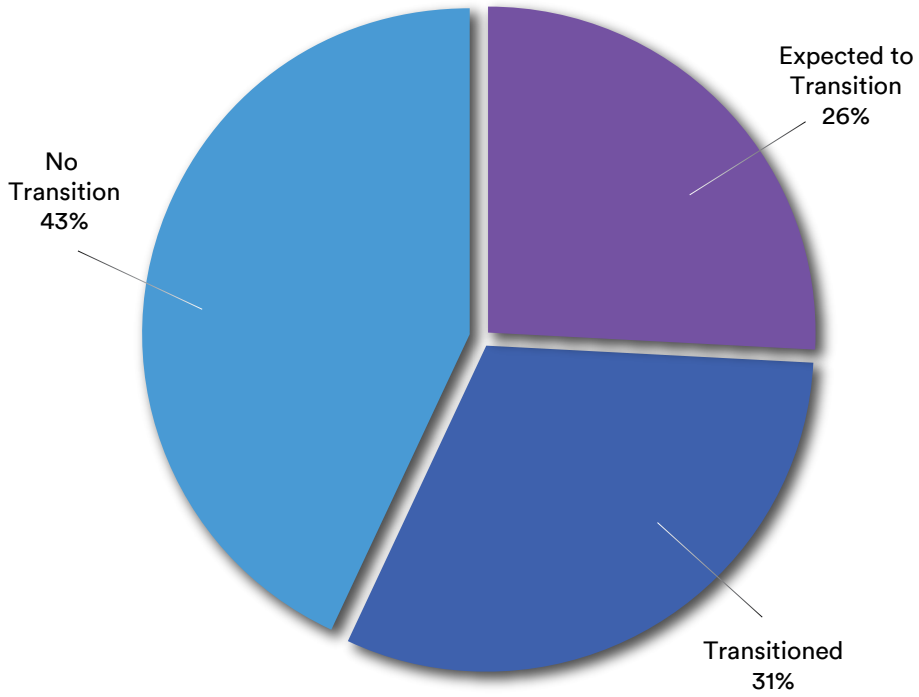
14 GAO summary of DOD regulations. | GAO-17-499; DoD RDT&E Budget Activity Descriptions. Emphasis added.

Together, these answers reveal that 379 out of 670 RIF awards (57%) either have transitioned to Military use or are expected to transition in the near future. The findings are consistent with the GAO RIF Report – that many of these projects provide value to DoD and will likely transition in the future. This question is important given the age of the awards (some were funded as recently as September 2017 and completed in September 2019) and the barriers to timely acquisition and implementation of technology.

While 57% of RIF awards from this period have already transitioned to Military use or are expected to transition in the near future, this number is likely an underestimate. Some negative responses were based on uncertainties about Military needs and acquisitions processes or the need for additional funding to finalize the technology for specific Military applications.

Figure 2 charts these findings and shows that 57% of RIF awards have either transitioned to U.S. Military use or are expected to transition in the near future. In total, 379 of the 670 RIF awards have either transitioned to Military use or are expected to transition soon. Therefore, DoD should expect at least 57% of projects to lead directly to Military use.

Figure 2



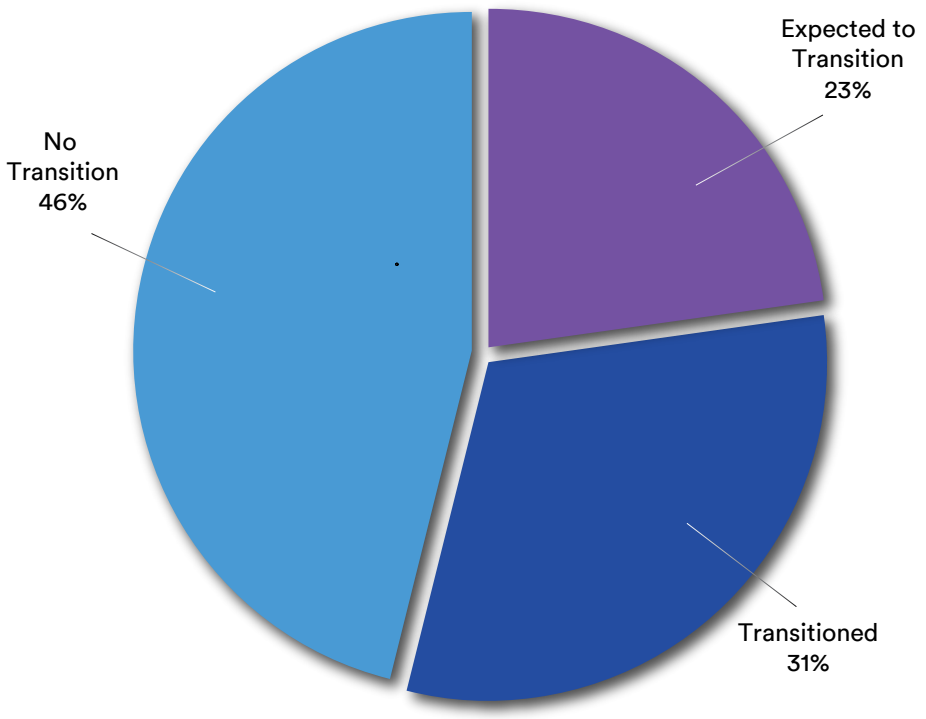
Percentage of RIF awards that have transitioned to U.S. Military use, FY 2011-2016

II. Transition of RIF Awards that Resulted from Prior Small Business Innovative Research/Technology Transfer Awards

Of the 399 RIF awards determined to have been derived from prior SBIR/STTR projects, 215 (54%) have transitioned or are expected to transition to Military use in the near future. Of these, 125 (31%) have already transitioned to Military use.

Figure 3, following, shows the percentage of RIF awards known to be derived from prior SBIR/STTR awards that have already transitioned (31%), are expected to transition soon (23%), or have not transitioned (46%). These rates closely follow those of the overall award set.

Figure 3



Transition status of 399 SBIR/STTR-derived RIF Awards, FY 2011-2016

III. Transition Rates by Year and Awarding Component

Figures 4-9, following, display transition rates by award year and the DoD issuing organization. The years refer to the fiscal year of the BAA for RIF awards. In most cases, the award was not actually funded until near the end of the fiscal year following the BAA.

Figure 4, following, displays the transition rates by year for all 670 awards. The strongest trend is the portion of awards expected to transition in the near future which diminishes with age. Understandably, this rate is higher among the younger awards and lower among older awards.

Figure 4

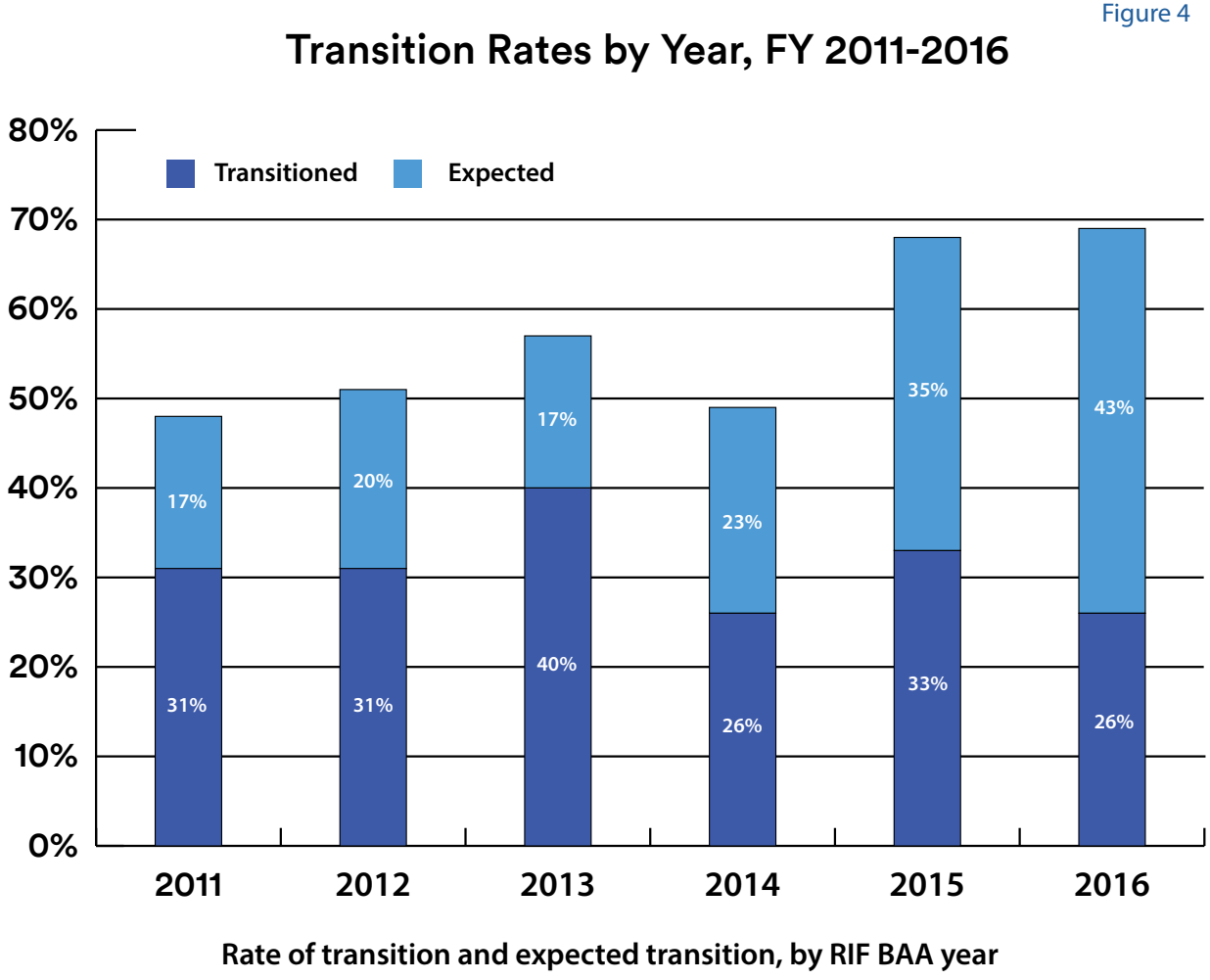
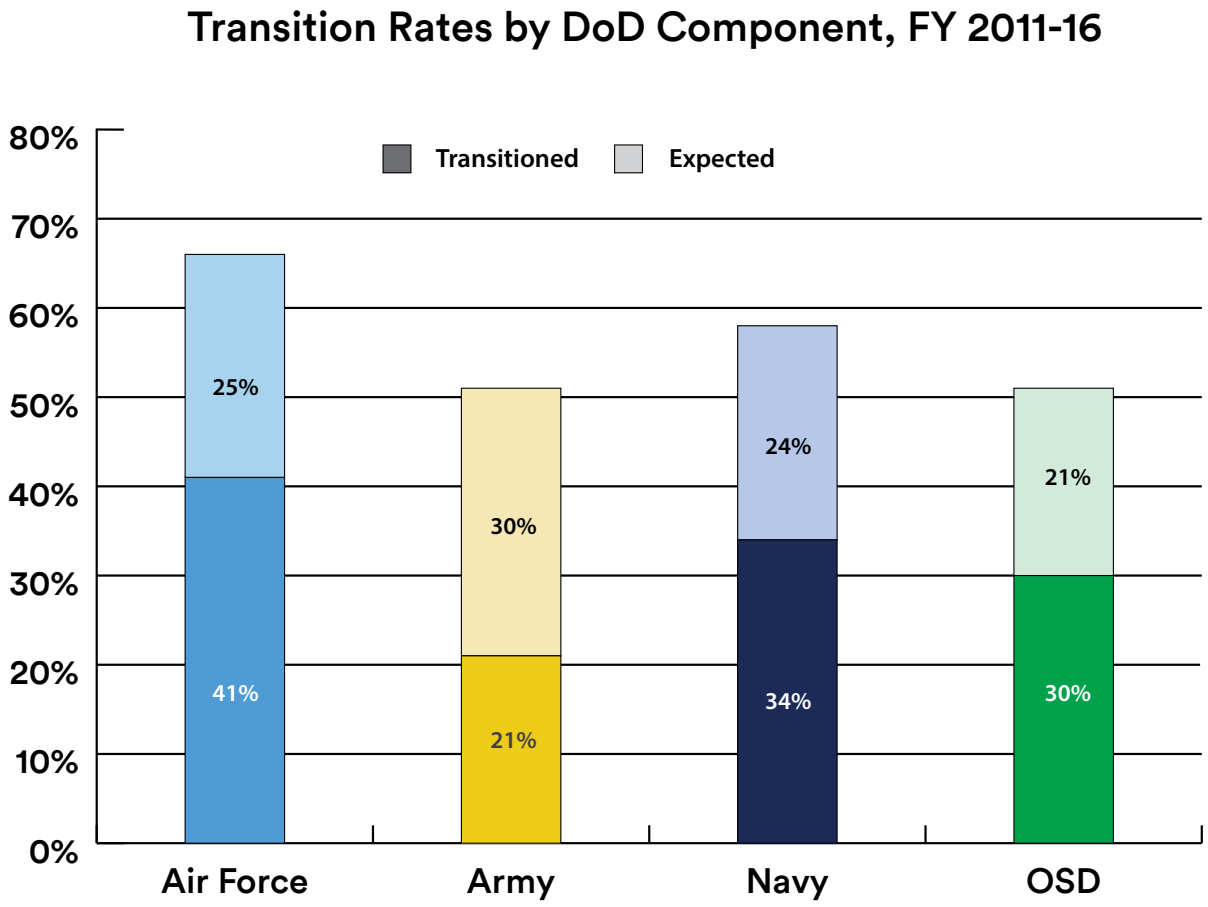


Figure 5 displays the overall transition rates by DoD Component. In this case, OSD includes all RIF awards distributed outside of the Army, Navy, and Air Force.

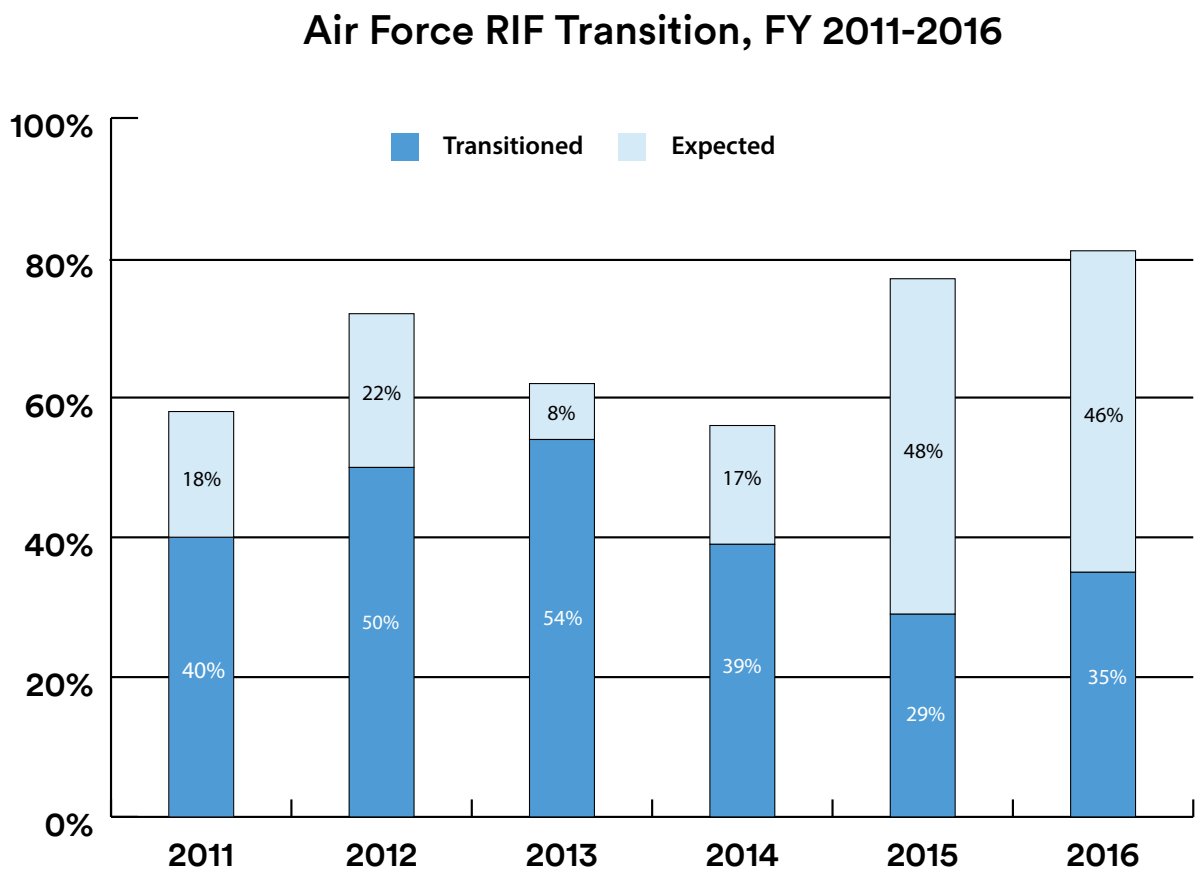
Figure 5



Rate of transition and expected transition, by DoD Component

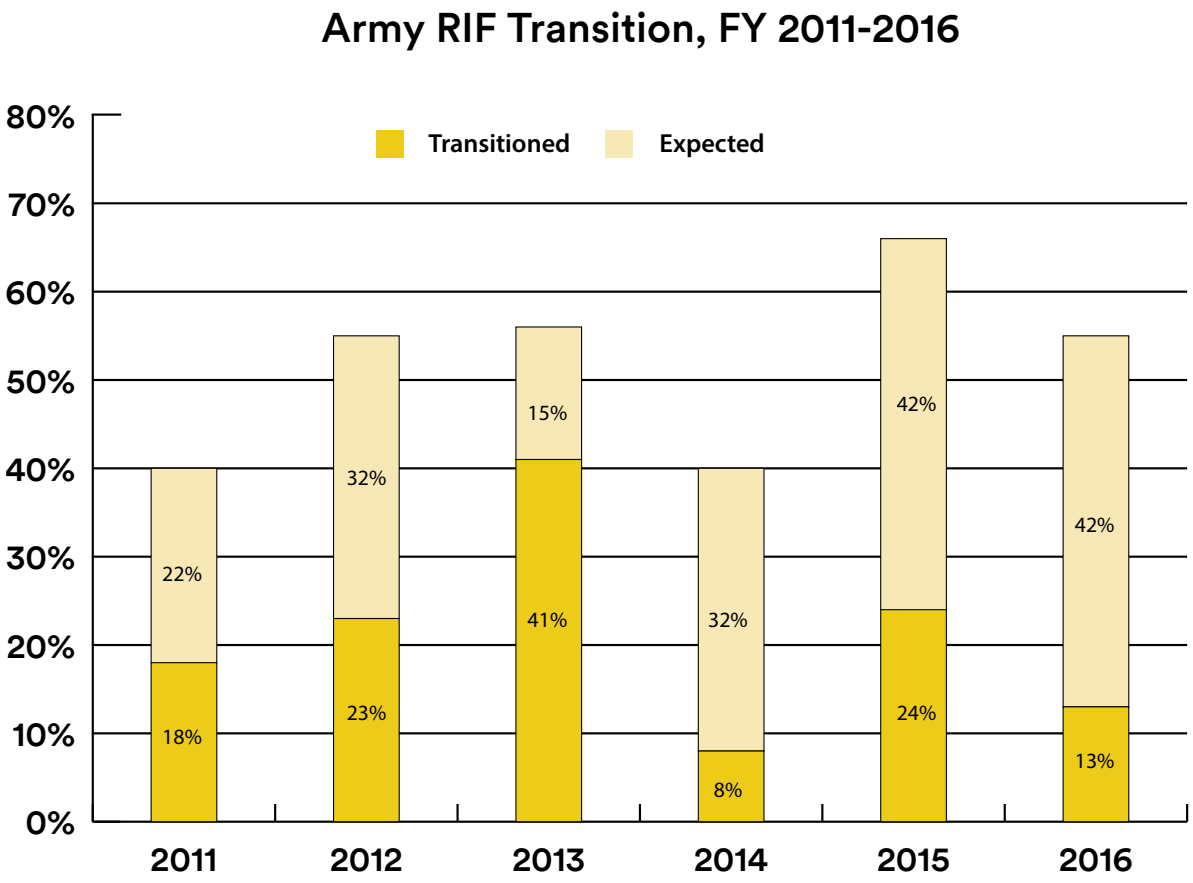
Figures 6, 7, 8, and 9 display the transition rates of Air Force, Army, Navy, and OSD RIF awards by BAA fiscal year.

Figure 6



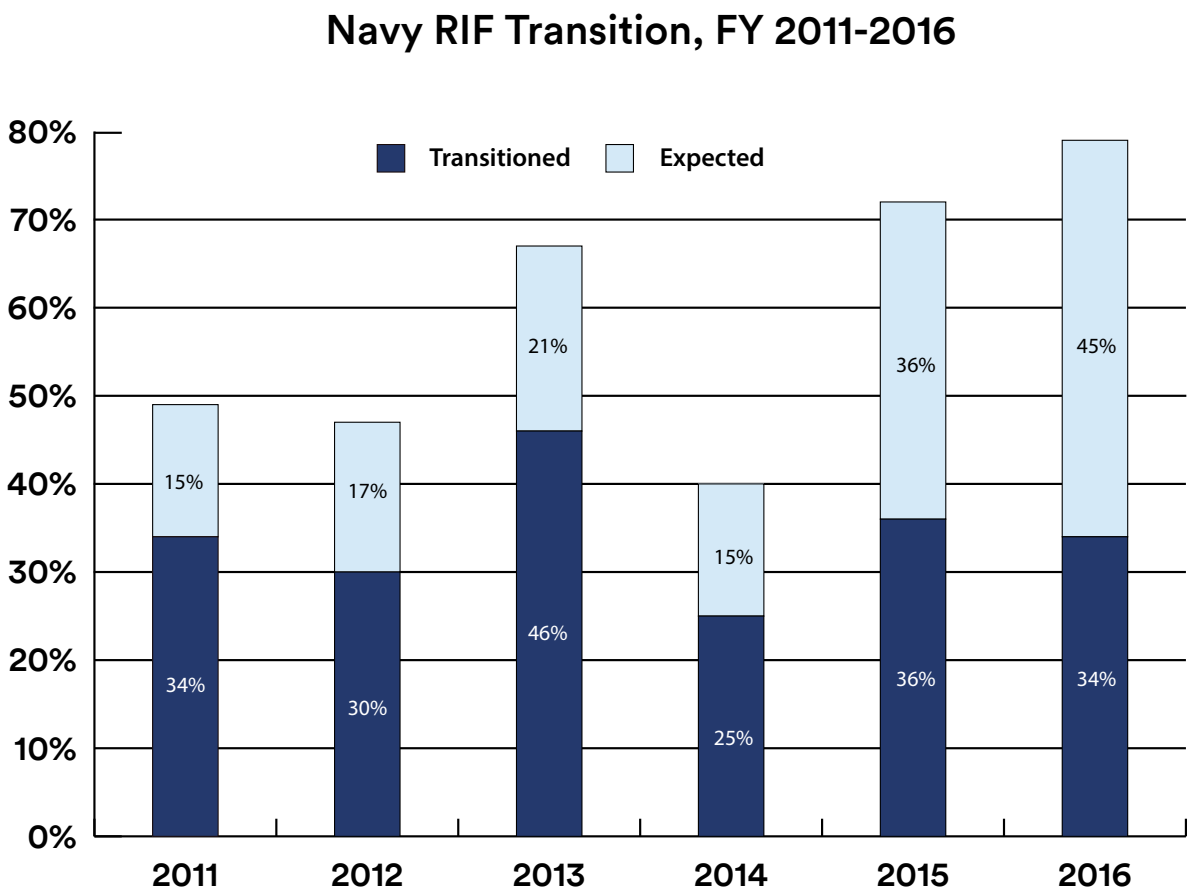
Rate of transition and expected transition, by RIF BAA year, Air Force

Figure 7



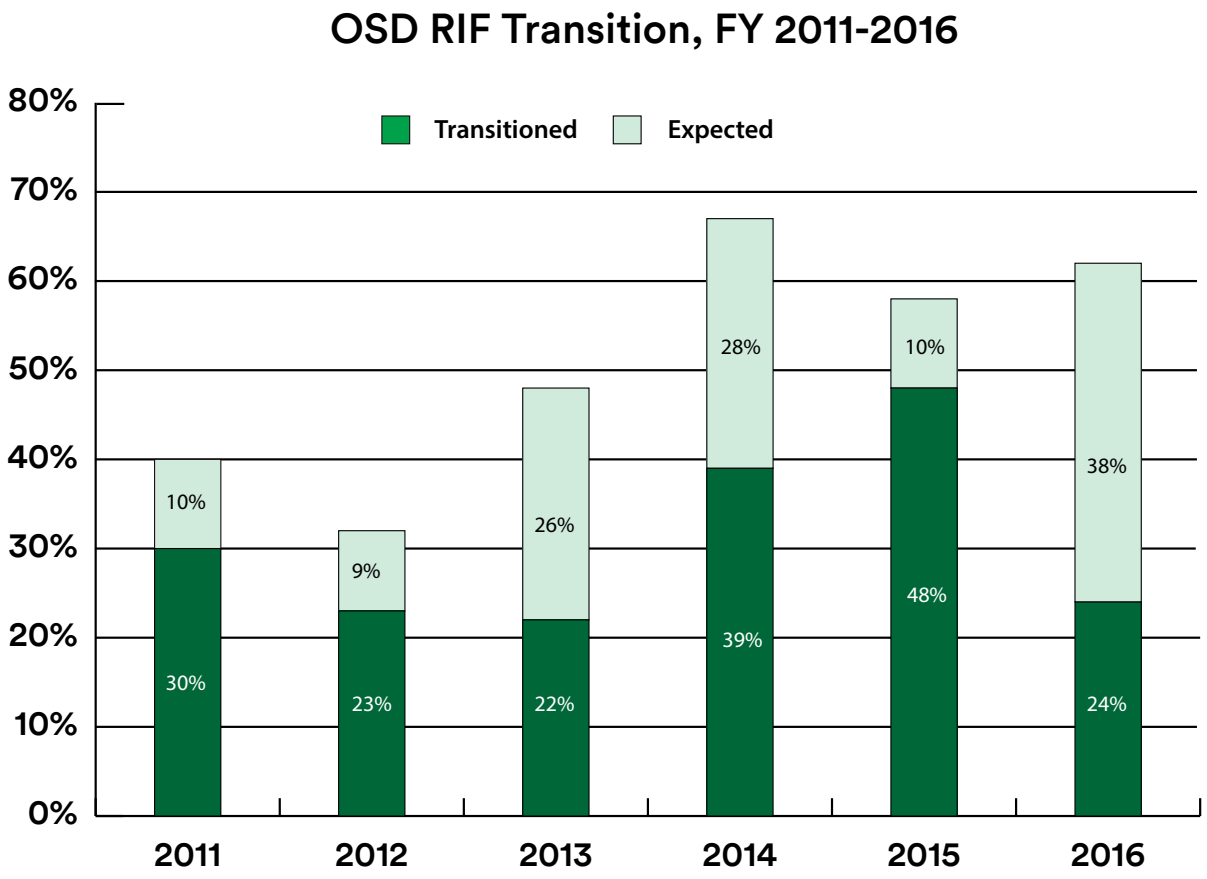
Rate of transition and expected transition by RIF BAA year, Army

Figure 8



Rate of transition and expected transition by RIF BAA year, Navy

Figure 9



Rate of transition and expected transition by RIF BAA year, OSD

The data indicate certain trends in transition rates. For example, there were generally lower transition rates for the most recent years for most DoD Components. In addition, there were higher anticipated transition rates for the more recent awards, as would be expected. An apparent trend showing improved transition rates for FY 2011 to FY 2013 for DoD RIF awards could reflect improvements after a new program start. However, transition rates for the FY 2014 Navy RIF BAA, and especially for the Army in the same year, appear somewhat anomalous. These findings could be further evaluated by the Services, focused on the topics or other considerations that occurred that year.

d. Product and Service Sales

The next series of questions focused on product and service sales resulting from RIF awards.

1. Military Sales

Not all of these projects were intended to result in a product or service with sales, but most transitioned awards have done so. Of the transitioned technologies, 144 (69%) resulted in sales of products or services to the Military. The aggregate amount of these sales was $2.1 billion. Of those awards expected to transition soon, 34 (20%) had already sold products or services to the Military. These sales, totaling $253 million, were usually for experimental prototypes and other orders used for testing and analysis.

These 178 awards—27% of all RIF awards and 47% of those currently or expected-to-be transitioned—resulted in sales to the Military, totaling $2.4 billion. The total amount of Military sales is nearly double the total invested in all RIF awards for this period, indicating a strong return on investment to the Military. Table 1 below displays the aggregated Military sales findings.

Table 1

AWARD STATUS	COUNT	SALES TO THE MILITARY		
		Count	Proportion	Amount
Transitioned	208	144	69%	$2.1 Billion
Expected to Transition	171	34	20%	$253 Million
Transitioned or Expected to Transition	379	178	47%	$2.36 Billion*

*Numbers may not add due to rounding.

Sales of RIF Technologies to U.S Military, FY 2011-2016
Awards or Projects

The goal of the RIF is to develop technology for Defense requirements. However, developing a commercial product for sale to civilian and other markets is a valuable motivator for recipient companies. Recipients next shared information on any commercial or civilian sales resulting from their RIF awards.

ii. Commercial (Civilian) Sales

Among transitioned awards, 54 (26%) had sold products or services to non-DoD customers. These sales totaled $387 million. Of the technologies expected to transition in the near future, 21 (12%) had non-DoD (civilian) sales. Overall, 75 (20%) of the transitioned or expected-to-transition technologies had civilian sales, representing 11% of all the RIF awards in the survey. Table 2 below shows these findings.

Companies stated that altogether 75 RIF awards had resulted in non-DoD sales totaling $410 million. Among the customers for these non-DoD sales are U.S. law enforcement and the militaries of U.S. allies, providing additional indirect benefits to DoD.[15]

Table 2

AWARD STATUS	COUNT	COMMERCIAL SALES		
		Count	Proportion	Amount
Transitioned	208	54	26%	$387 Million
Expected to Transition	171	21	12%	$22 Million
Transitioned or Expected to Transition	379	75	20%	$410 Million*

*Numbers may not add due to rounding.

Commercial sales of RIF technologies, FY 2011-2016
Awards or Projects

e. Rapid Innovation Fund Project Results

i. Transition Categorization

The next question applies to the 208 RIF awards that transitioned to U.S. Military use:

What was the result of the project?

This question included five response options:

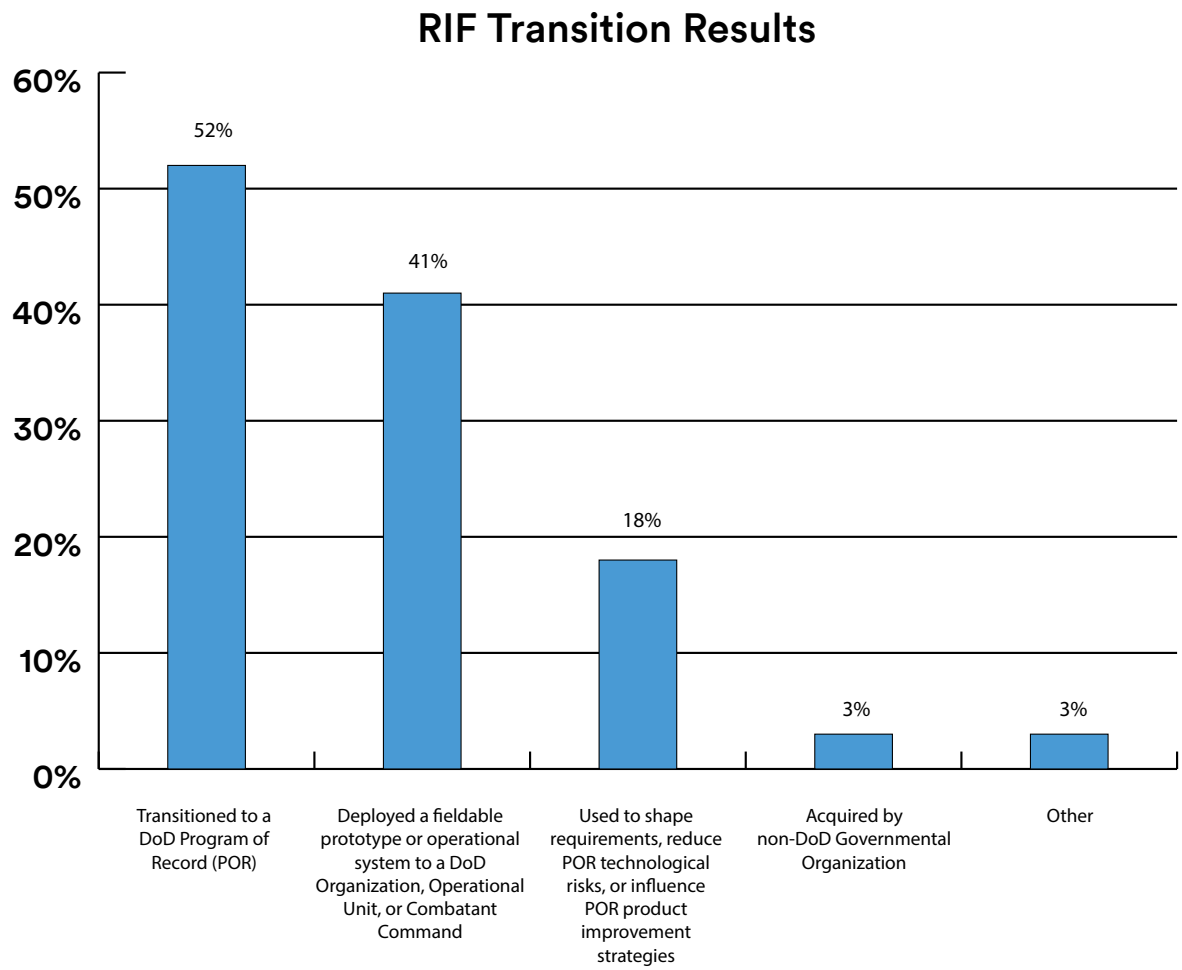
- Transitioned to a DoD Program of Record (POR);
- Deployed a fieldable prototype or operational system to a DoD Organization Operational Unit or Combatant Command (CCMD);

15 In alignment with the second pillar of the 2018 NDS, to "Strengthen Alliances and Attract New Partners."

- Used to shape requirements, reduce POR technological risks, or influence POR product improvement strategies;
- Acquired by non-DoD Governmental Organization
- Other (clarify/define)

Survey respondents were able to pick more than one option, if applicable. Figure 10 below displays the frequency of each response.

Figure 10



Project results by transition category

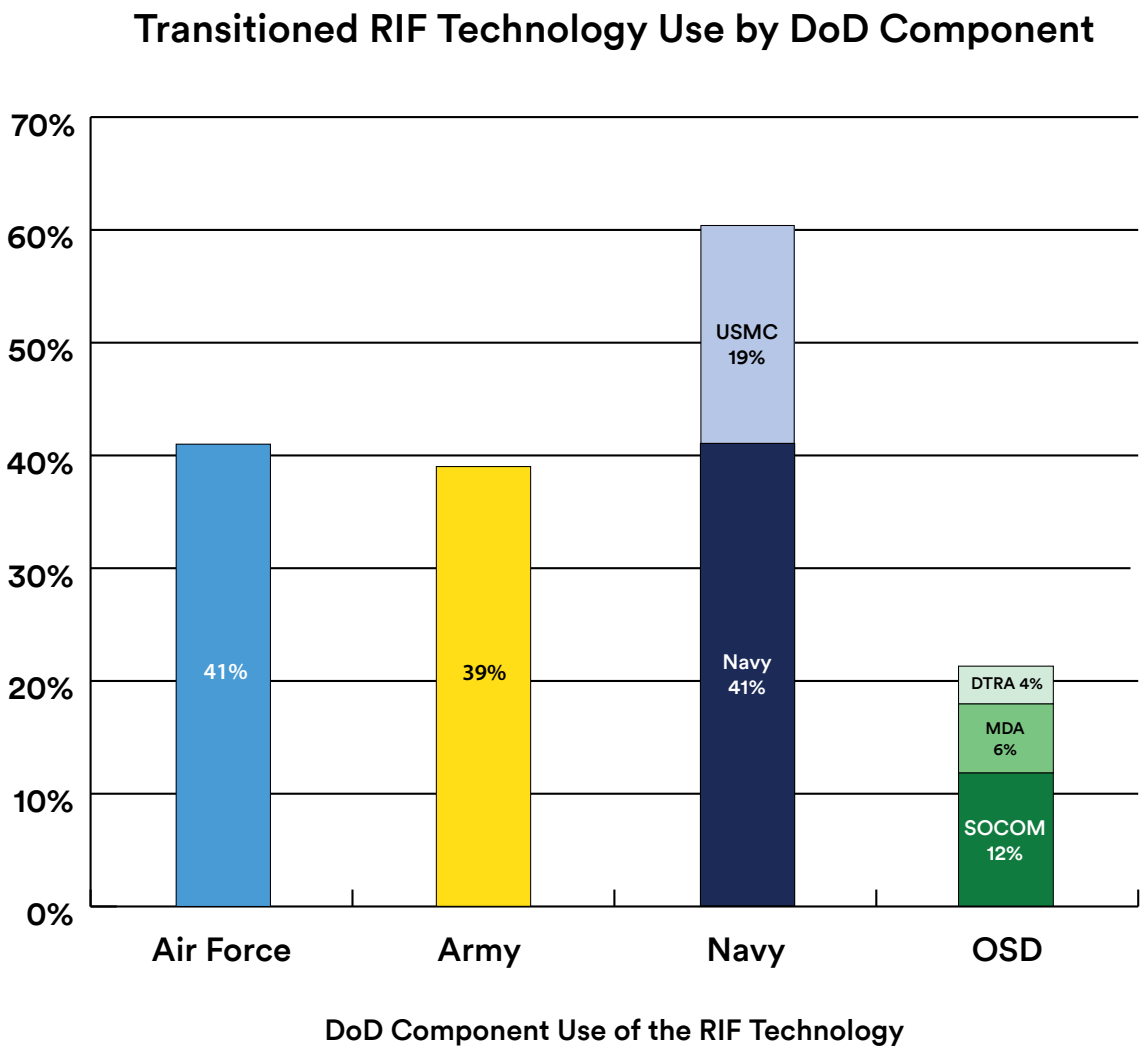
Of the transitioned technologies, 108 (52%) are currently used in a POR. According to the GAO RIF Report, one important component for successful RIF transition is having an identified POR as a transition partner. If a POR is identified at the start of a RIF project, transition success will likely be much higher. Slightly less common were the 85 technologies (41%) deployed as a fieldable prototype or operational system. Thirty-eight, or nearly one in five (18%) transitioned RIF projects were used to shape requirements, reduce technological risk, or influence

product improvement strategies. Seven of these technologies (3%) were acquired by non-DoD government organizations. In six cases (3%), the respondents chose "other."

ii. Use Per Service or Department of Defense Organization

Next, the survey sought to identify the DoD Component currently using the resulting RIF technology. Figure 11 shows that the major Service branches—Navy (41%), Air Force (41%), and Army (39%)—are the most common end users of transitioned technology. Less common was use by the U.S. Marine Corps (USMC, 19%) and non-Service DoD Components, including the U.S. Special Operations Command (SOCOM, 12%), the Missile Defense Agency (MDA, 6%), and the Defense Threat Reduction Agency (DTRA, 4%). In many cases, multiple Services or DoD Components were end-users, resulting in a total exceeding 100%.

Figure 11



The survey included an open-ended question asking about specific systems and PORs in which the technologies are being used. While these answers cannot be easily quantified using charts and descriptive parameters, many examples are provided in the technical summaries of the appendix as well as in the in-depth success stories.

iii. Cost Reduction Estimations

Next, the survey focused on cost reduction (cost avoidance). The first question was simple:

Did the transitioned technology reduce acquisition or lifecycle costs?

For 143 (69%) of the RIF transitioned technologies, the answer was "Yes."

The next question requested an estimate of the overall cost savings the technology provided to the DoD. Researchers quickly discovered that this question was difficult for respondents to answer. Most award recipients felt unqualified to estimate how their technology reduced costs within DoD. Even when they were certain cost savings occurred, an estimate was difficult to quantify. Survey respondents expressed strong reluctance to provide these numbers. Where numbers were offered, the methods of estimating them varied. When a cost-savings figure was provided, the most conservative estimates were used.

If aggregated, the total estimated cost savings collected through the survey would be $4.5 billion. These estimates were provided by 63 RIF award recipients. Of these, 10 projects accounted for 90% of the total estimated value. In many cases, companies stated that estimates were obtained from DoD Program Managers for savings across the lifetime of the program. Additional project details can be found in the appendix of this report. Examples of program savings included:

- F-35 batteries with greatly reduced maintenance costs and doubled lifetimes;
- Advanced engine-coating technology already applied across multiple helicopter engine platforms, shown to greatly reduce maintenance costs and increase service life in harsh environments;
- Eliminating expensive cryo-coolants and associated hardware for infrared sensors used on the F-35;
- Improving structural integrity and reducing maintenance on multiple aircraft platforms;
- Multiple additional projects that reduce maintenance time and costs for Military aircraft platforms, resulting in large cumulative savings.

f. Technology Impacts

1. Innovation Categorization

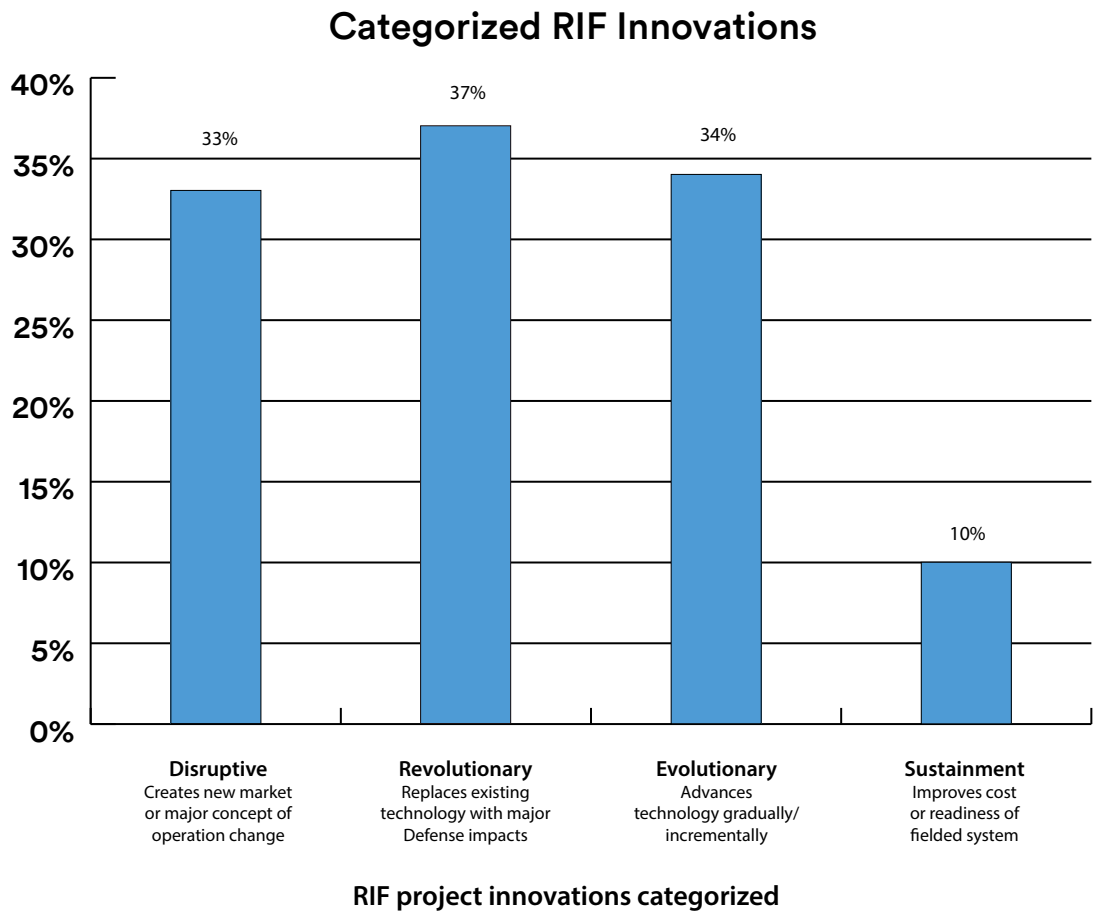
The final section of the survey included a series of questions to categorize each technology in order to discover the importance of the innovation, identify its overall impact, and define any additional impacts it had on the Military. These questions were only asked if the technology had transitioned to Military use. The first of these questions was:

Please categorize your innovation as one of the following:

- Disruptive: Creates new market or major concept of operation change;
- Revolutionary: Replaces existing technology with major Defense impacts;
- Evolutionary: Advances technology gradually/incrementally;
- Sustainment: Improves cost or readiness of fielded system.

The results are graphed in Figure 12.

Figure 12



The most frequent responses to this question were chosen in nearly equal proportions. Revolutionary (37%), Evolutionary (34%), and Disruptive (33%) were each used about one third of the time to describe the innovations, with little overlap. Only 10% of surveys reported technology that was helpful in Sustainment. Again, respondents were allowed to choose more than one response, therefore the sum of responses exceeds 100%.

ii. Rapid Innovation Fund Objectives

The next two questions specified simple "yes" or "no" answers:

Did the technology improve the timeliness and/or thoroughness of test and evaluation outcomes for the DoD?

For 103 out of 208 (50%) of transitioned RIF technologies, the answer was "yes" to this question.

Did the technology reduce technical risk for the DoD?

Of the 208 transitioned technologies, 164 (79%) answered "yes" to this question.

iii. Overall Military Impact Categorization

The next question requested a description of the overall impacts of the RIF award, again allowing selection of more than one result:

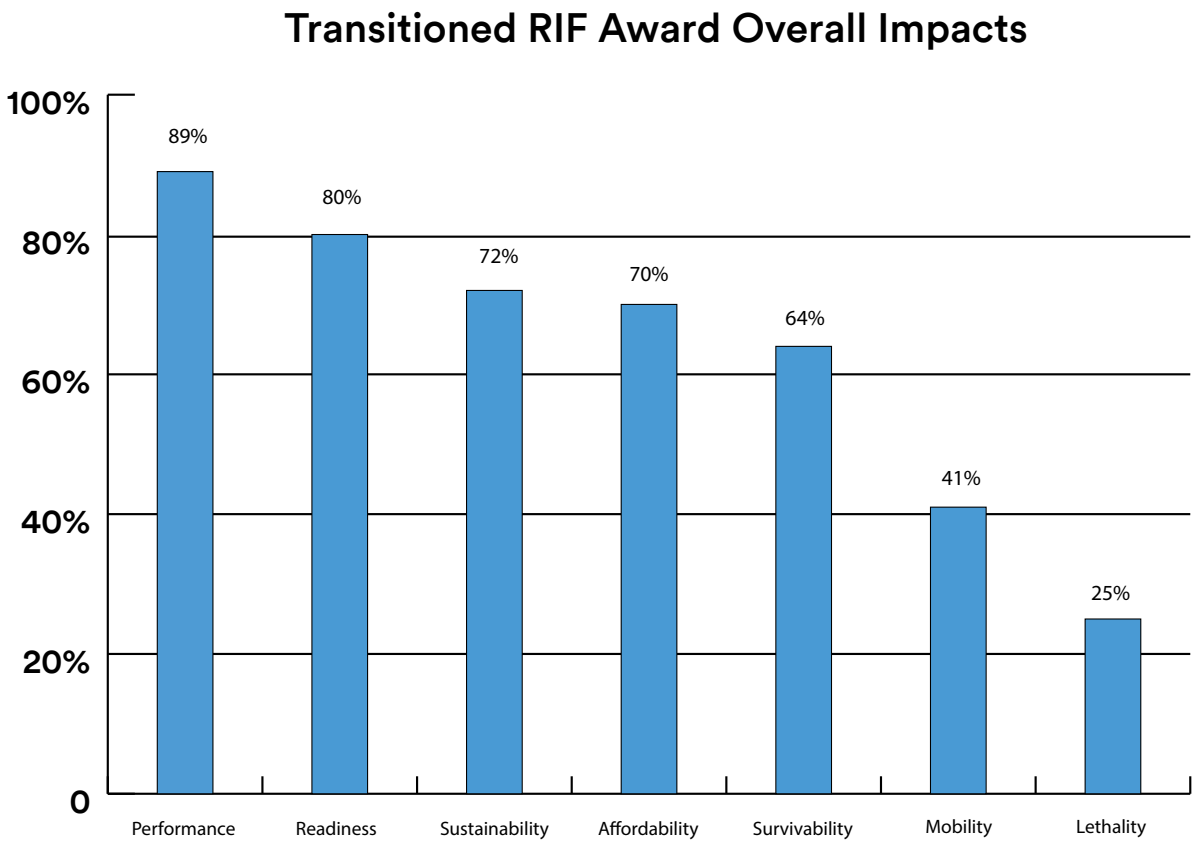
Can you categorize the overall impacts for the Military? (Pick one or more as applicable.)

The multiple choices offered were:

- Performance
- Readiness
- Sustainability
- Affordability
- Survivability
- Mobility
- Lethality

Figure 13, following, displays the frequency of these choices among transitioned awards, with results indicating that most respondents selected multiple results for the overall impact categories.

Figure 13



Overall Impacts of RIF awards by Category

Note that these responses generally support the first and third pillars of the 2018 National Defense Strategy (NDS), to "Build a More Lethal Force" and to "Reform the Department for Greater Performance and Affordability."

The next question sought out additional impacts. These choice selections tended to be more specific than previous questions.

Were there any additional impacts from the transitioned technology?

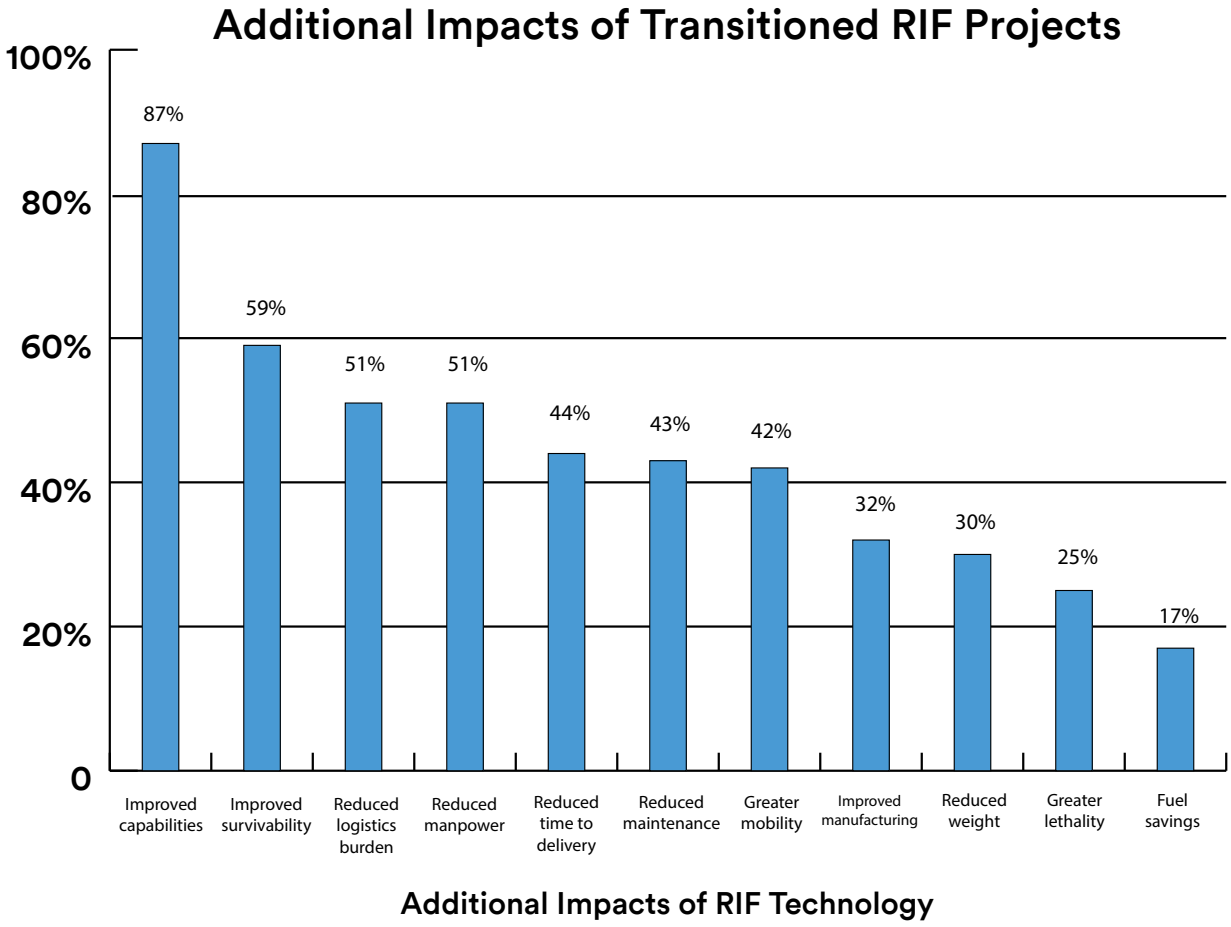
This question was included to identify more specific areas where the RIF provided tangible benefits to Military capabilities. The response options were meant to facilitate a more detailed description of outcomes while keeping the multiple choice format.

The optional responses, from which respondents were able to choose more than one, included:

- Improved capabilities
- Improved survivability
- Reduced logistics burden
- Reduced manpower
- Reduced time to delivery
- Reduced maintenance
- Greater mobility
- Improved manufacturing
- Reduced weight
- Greater lethality
- Fuel savings

Figure 14 graphs the results of this question.

Figure 14



As Figure 14 shows, the project outcomes created a number of additional impacts to support Warfighter capabilities. Overall, 87% of projects resulted in improved capabilities which supports the conclusion that the Military is receiving usable innovations from the RIF. The remaining categories cover a broad variety of impact areas and reflect the diversity of these successful projects.

iv. Other Measures of Success

The final survey question asked respondents to share any additional examples of their successes:

> Can you report any other measures of success?

While most respondents declined to answer this question, deferring to the outcomes listed above, the few that did answer specified several common indicators. Most frequent was the opening of broader commercial and civilian markets. The common technological needs of the various DoD Components provide many opportunities for the use of RIF technologies. Similarly, non-DoD end users in commercial markets are diverse. They include private companies and also first responders such as police and fire departments. A less common but still frequent measure was production of publications and reports, showing that RIF research contributes to the knowledge base that will support future Military innovations.

6. Conclusion

In conclusion, the findings of this study describe the self-reported outcomes of 96% of all RIF awards from FY 2011 through FY 2016 RIF solicitations which covered all awards issued through FY 2017. The results show that the RIF has been very effective at meeting the objectives outlined in the FY 2020 NDAA by:

- Stimulating innovative technologies;
- Reducing acquisition or lifecycle costs;
- Addressing technical risk; and
- Improving the timeliness and thoroughness of test and evaluation outcomes.

The survey results are in alignment with the three pillars of the 2018 NDS, specifically in that the project outcomes have helped to "Build a More Lethal Force," "Strengthen Alliances and Attract New Partners," and "Reform the Department for Greater Performance and Affordability."

The majority (57%) of RIF projects from this period have already transitioned to Military use or are expected to transition in the near future. These successful RIF projects effectively cover all of the DoD modernization priorities, as highlighted in the 2018 NDS. They have also met additional urgent Defense needs to improve military performance capabilities, readiness, and sustainability, as well as reduce costs for the DoD. The technical project summaries included within this report (Appendix 2), and additional comprehensive success stories being developed, all highlight specific outcomes and added capabilities that RIF projects have provided for the U.S. Military.

The findings in this study also highlight the major role of SBIR/STTR in contributing to RIF outcomes. Of the 670 RIF awards for the period, 399 (60%), with 62% of all RIF funding, were verified as being directly derived from prior SBIR/STTR projects. As many additional RIF awardees had prior SBIR/STTR awards, the number could likely be as high as 478, or 71% of all RIF projects, accounting for 73% of all RIF funding. The RIF projects derived from prior SBIR/STTR projects transitioned to the Military at effectively the same rate as all RIF awards in this study.

This study provides comprehensive qualitative and quantitative findings for the RIF while delineating the broad categories of impacts for RIF projects that transitioned to Military use. Additionally, successful RIF projects resulted in $2.4 billion in U.S. Military sales, nearly double the initial RIF investment, demonstrating that many RIF projects are meeting important Military needs. The comprehensive findings, success stories, and technical summaries provided in this report make clear the many specific and important impacts the RIF has had in support of the U.S. Military.

Appendix 1

Department of Defense Letter of Authorization

The letter of authorization on the following pages was signed by the Director of the RIF Program. The letter was provided to TechLink, which used it to validate the authenticity of the survey. It emphasizes the confidential nature, data aggregation, and importance of this study.

RESEARCH
AND ENGINEERING

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3030 DEFENSE PENTAGON
WASHINGTON, DC 20301-3030

October 7, 2019

RE: DEPARTMENT OF DEFENSE RAPID INNOVATION FUND (RIF) PROGRAM REVIEW

Dear Former RIF Recipient:

Congratulations on having received Department of Defense (DoD) RIF Program funding between 2011 and 2016. The DoD RIF Program is very competitive, and as a past participant you are among a select group of companies. In response to a congressional mandate in the FY 2020 National Defense Authorization Act (NDAA), I am currently conducting a thorough review of the DoD RIF Program. Evaluating the effectiveness of the DoD RIF Program is of the utmost importance to both Congress and DoD leadership. As a participant in the DoD RIF Program, you have a unique perspective on program outcomes. The DoD would, therefore, be very grateful for your cooperation in this review. I understand that your time is valuable, but I assure you that your feedback is very important to the DoD and to Congress in making informed decisions regarding the DoD RIF Program's future—decisions with direct implications for businesses like yours that could receive program funding. In the coming months, you will be asked to share your perspectives in an official review of the outcomes of your DoD RIF Program experience.

As Director of the DoD RIF Program, I have engaged the services of TechLink, a trusted DoD partnership intermediary since 1999, based at Montana State University. This will be the 13th national impact review that TechLink has conducted for the DoD. TechLink will be examining the DoD RIF Program's effectiveness in stimulating innovative technologies, reducing acquisition or lifecycle costs, addressing technical risk, reducing maintenance and manpower, improving survivability, increasing mobility, reducing weight, improving lethality, stimulating military and commercial sales, and improving the timeliness and thoroughness of test and evaluation outcomes.

TechLink will maintain strict business confidentiality. All information and data gathered will be strictly controlled and protected. No individual company information will be disclosed to any government entity, including the DoD. Any data reported will be aggregated with the information from all other participants.

TechLink's research specialists will contact you beginning in October 2019 to gather critical information regarding your prior DoD RIF Program award(s). Please help ensure a successful DoD RIF Program review by being responsive and providing the requested information. The results will help Congress and the DoD improve the RIF program. Your insights will directly impact future small business participants and ultimately, U.S. Warfighters.

RESEARCH
AND ENGINEERING

THE UNDER SECRETARY OF DEFENSE
3030 DEFENSE PENTAGON
WASHINGTON, DC 20301-3030

We look forward to your participation in this important program review. If you have any questions or concerns, please contact Dr. Michael Wallner with TechLink at 406-600-6420 or Ted Bujewski, Director of the DoD RIF Program, at theodore.j.bujewski.civ@mail.mil or 571-372-6256.

Very Respectfully,

Ted Bujewski, Director
DoD Rapid Innovation Fund Program
Office of the Under Secretary of Defense
for Research and Engineering

Appendix 2

Technical Summaries of Rapid Innovation Fund Impacts

The following are brief summaries of individual RIF project outcomes, showing how their results integrate with and support the U.S. Defense mission, as described in the 2018 NDS, and meet the NDS modernization priority specified for each.

Space-Based Early Warning System Adopts ARROW Technology

Modernization Priority: Space
NDS Pillar: Force Readiness and Lethality
Firm: SciTec, Inc.
Location: Princeton, NJ
2014 Air Force RIF / PEO BES (Business & Enterprise Sys.) (Start Date 9/16/15)
Title: *Architecture for Real-time Overhead Persistent Infrared Wideband*

The Space-Based Infrared System (SBIRS) is a consolidated system intended to meet the United States' infrared space surveillance needs. The SBIRS program is designed to provide key capabilities in the areas of missile warning, missile defense, and battlespace characterization via satellites and hosted payloads in Geosynchronous Earth Orbit (GEO) and Highly Elliptical Orbit (HEO). The USAF Space and Missiles Center (SMC) manages the SBIRS Program. SMC awarded a RIF contract to SciTec, Inc. of Princeton, NJ, to provide the Architecture for Real-time Overhead Persistent Infrared Wideband (ARROW), which processes collection modes for SBIRS sensors that were previously unavailable for operational uses. SciTec's ARROW provides the only Air Force capability to exploit the full GEO Starer sensor data stream which provides coverage for theater missions and intelligence areas of interest with its fast revisit rates and high sensitivity, and operates within the OPIR (Overhead Persistent Infrared) Battlespace Awareness Center (OBAC) in the Space Exploitation Ground Architecture (SEGA) and at the Threat Analysis Cell (TAC). ARROW has additionally been integrated into a demonstration version of the Future Operationally Resilient Ground Evolution (FORGE) framework, supports multiple ongoing Tools, Applications, and Processing Lab (TAP Lab) development efforts, and is being leveraged as an operational pathfinder by the Missile Defense Agency (MDA). SciTec's ARROW technology was developed under the Air Force RIF, and was derived from prior SBIR efforts.

Trusted Integrated Circuit Life-Cycle Management and Supply Chain Risk Management

Modernization Priority: Microelectronics
NDS Pillar: Business Reform
Firm: Nimbis Services, Inc.
Location: Oro Valley, AZ
2012 Air Force RIF / AFNWC (Air Force Nuclear Weapons Center) (Start Date 9/24/13)
Title: *Trusted Silicon Stratus - Silicon Life Cycle Risk Management Ecosystem*

The DoD's relative obscurity of consumption within the semiconductor market has put DoD semiconductor design teams in an increasingly intractable position of engineering effectiveness, cost efficiencies, design productivity, and general viability to maintain future competitiveness in trusted microelectronics. In response to these challenges, the Air Force partnered with Nimbis Services in Oro Valley, AZ, through its RIF to develop the Trusted Silicon Stratus-Supply Chain Risk Management Cloud (TSS-SCRM) solution which was based in part on prior SBIR technology funded by DARPA. The Nimbis TSS-SCRM is a novel microelectronics life-cycle verification ecosystem to enhance microelectronics supply chain risk management for DoD R&D teams, contractors, government research laboratories, universities, commercial organizations and innovation communities.

Green Technology Improves Life of Air Force Missile Launchers

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: IBC Materials & Technologies
Location: Lebanon, IN
2011 Air Force RIF / PEO Weapons (Start Date 9/25/12)
Title: *Full-Rate Production of Missile Rail Repairs*

Missiles carried by fighter aircraft result in significant wear of the missile launcher rails, limiting their useful life. Hard anodizing was the standard protective coating for the aluminum missile rails for many years. Not only does the anodizing coating provide only limited life, the anodizing process also uses hazardous chemicals requiring costly cleanup and remediation. Through support from the Air Force RIF, IBC Materials & Technologies, Inc. developed and implemented a Plasma Electrolytic Oxidation (PEO) nano-ceramic coating process to replace the hard anodizing coating. The PEO coating process is environmentally friendly and uses only water-based, low concentration electrolyte. The IBC-developed PEO coating provides a ten-fold improvement in corrosion and wear resistance performance. PEO coated rails have been tested in flights for more than 5 years with no wear, resulting in significant savings to the USAF. As a direct result of the USAF RIF initiative, a production PEO coating facility for LAU-12X series missile

launcher rails is operational at IBC Materials & Technologies in Lebanon, IN. This RIF contract was a formal Phase III award based on prior SBIR work.

Secure Cloud Based Weather Services Increase Security at Reduced Costs

Modernization Priorities: Cyber, General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Solid State Scientific Corporation (SSSC)
Location: Hollis, NH
2013 Air Force RIF / PEO Battle Mgmt (Start Date 9/16/14)
Title: *Commercial Cloud Common Computing Environment (C4E)*
2014 Air Force RIF / PEO Battle Mgmt (Start Date 7/30/15)
Title: *Protected Execution Cloud Environment*
2015 Air Force RIF / PEO Fighter/Bomber (Start Date 6/17/16)
Title: *Innovative Computational Technologies for AF Weather Operations*

The importance of weather on the battlefield can't be understated. Many battles are won or lost due to the impact of weather. The Air Force, Army, Special Operations Forces and others rely on U.S. Air Force Weather (AFW) environmental information and forecasts for mission planning, combat operations by Military units in the field, and airfield and flight operations. The Air Force RIF funded Solid State Scientific Corp. (SSSC) of Hollis, NH, to migrate the Air Force Weather Branch AFW Platform-as-a-Service/Infrastructure-as-a-Service to the cloud and to design and build an Air Force Weather Virtual Private Cloud. Eventually the cloud migration will include operations for all AFW applications. By migrating applications to the cloud the need for physical data centers will be reduced and the Air Force will be able to lower its total cost of cyber operations. This work by SSSC was derived from prior DoD SBIR work by the company.

Air Force RIF Technology Plays Key Role in F-35 Assembly

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Business Reform
Firm: Variation Reduction Solutions Inc. (VRSI)
Location: Plymouth, MI
2013 Air Force RIF / PEO ISR&SOF (Start Date 9/9/14)
Title: *Integrated Laser Scanning for Closed-Loop Countersink Control in Robotic Drilling*

In production of the F-35 Lightning II, there was a problem in the manufacturing of the inlet ducts on the aircraft. Assembly workers had to drill hundreds of holes by hand in small confined areas which was imprecise and unsustainable. To resolve the problem, engineers at Northrop Grumman adopted a robotic system developed by Variation Reduction Solutions Inc. (VRSI). VRSI's six-axis Inlet Duct Robotic Drilling (IDRD) system was developed in partnership with the Air Force with funding from the Air Force RIF, following

earlier technology development under Air Force SBIR. The technology uses laser tracking for drilling and fastening in a confined area and a laser inspection system to evaluate the quality of each hole.

Air Force Maintenance-Free Radome Technology to Save Millions

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Ebert Composites Corp.
Location: Chula Vista, CA
2011 Air Force RIF / PEO Digital (formerly Battle Mgmt) (Start Date 9/13/12)
Title: *Advanced Composite Radome with Innovative Hydrophobic/Non-Delaminating Sandwich Material*

Composite radomes (radar domes) are structural, weatherproof enclosures that protect radar antennas. They are constructed of material that minimally attenuates the electromagnetic signal transmitted or received by the antenna. As radomes age, they are prone to delamination leading to catastrophic failure. As a solution to the problem Ebert Composites Corporation (ECC), Chula Vista, CA, has developed a new generation composite radome for the U.S. Air Force made from pultruded thermoplastic sandwich panels utilizing 3-D skin connecting fibers. ECC's radome was developed under the Air Force RIF to transition prior Air Force SBIR work, and was successfully installed on an existing radar tower at the 103rd Air Control Squadron (ACS) in Orange, Connecticut. The ECC radome is expected to be maintenance free for decades and would save the Air Force more than $130 million over a 30-year period.

Cold Spray Technology Reduces Maintenance Costs on the B-1 Bomber and Other DoD Weapons Systems

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: H. F. Webster Engineering Services (acquired by VRC Metal Systems, LLC)
Location: Rapid City, SD
2013 Air Force RIF / AFSC (Air Force Sustainment Center) (Start Date 9/19/14)
Title: *Wear Surface and Structural Repair Using Cold Spray*
2015 Army RIF / RDECOM (Start Date 9/29/16)
Title: *Metal Component Repair Using Cold Spray*

The Air Force fleet of B-1 bombers and many other weapon systems continue to age, but a new technology greatly reduces the cost of maintenance. Referred to as cold spray, the technology is a revolutionary welding process used to fix surfaces such as worn fastener holes on aircraft skin panels or expensive gear boxes. The cold spray process entails spraying a surface with metal powder at supersonic speeds which

creates a solid state weld with very little heat input to the substrate. These parts could not be effectively repaired with any other known technology. Through the RIF, Air Force maintainers have proven the process is effective in repairing B-1 forward equipment bay panels - each costing between $150,000 and $225,000. In addition, F-16s, F-15s, B-52s, M1A1 tanks, and Navy ships are also in line to benefit from cold spray according to a DoD spokesperson. Savings are estimated at greater than $100 million annually if implemented throughout the DoD. Research for the cold spray technology was conducted by H. F. Webster Engineering Services for the Army and Air Force with initial funding by the Air Force RIF, and subsequent Army RIF funding for additional Military applications.

Warheads Achieve Maximum Impact with No Unexploded Ordnance

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Orbital ATK (now Northrop Grumman Innovation Systems)
Location: Plymouth, MN
2016 Air Force RIF / AFNWCC (Start Date 6/22/17)
Title: *250 lb. AF Lethality Enhanced Ordnance (LEO) Flight Test Demo*

Cluster munitions are air-dropped or ground-launched weapons that release a number of smaller submunitions. First developed in World War II and currently part of many nations' weapons stockpiles, the use of cluster munitions has become highly scrutinized in recent years due to the risk posed from unexploded ordnance (UXO). In 2008, Defense Secretary Robert Gates signed a Pentagon cluster munitions policy directing the Military to only use weapons that do not yield more than one percent UXO, effectively launching the Alternative Warhead Program (AWP). Through funding from the Air Force RIF and support from the Air Force and Army, Orbital ATK began developing an alternative to existing cluster munitions which would produce zero residual UXO. Their project would lead to production of its Guided Multiple Launch Rocket System (GMLRS) Alternative Warhead (AW) for the U.S. Army. With a goal of eliminating UXO completely and maintaining effectiveness, the company successfully developed Lethality Enhanced Ordnance (LEO) technology. Instead of submunitions, LEO relies on inert projectiles placed inside the warhead. In tests, the Orbital ATK warheads with LEO technology achieved the Army's stated requirements for area effectiveness, but left behind no unexploded ordnance. By focusing on inert projectiles instead of submunitions in the warhead, LEO achieved the Army's requirement of maximum effectiveness without the possibility of residual UXO.

Air Force Technology Reduces Environmental Hazards, Cuts Costs for F-35 Program

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Business Reform
Firm: Triton Systems, Inc.
Location: Chelmsford, MA
2011 Air Force RIF / AFLCMC (Start Date 9/11/12)
Title: *Nickel Free Conductive Fillers*

Nickel-based materials are used in several components of today's fighter aircraft; however, working with these materials can be dangerous for installers and requires special handling procedures. To resolve the problem, the Air Force partnered with Triton Systems Inc. (TSI) in Chelmsford, MA, to find a solution. Through the Air Force RIF, TSI successfully transitioned prior SBIR work to develop a technology to produce nickel-free material systems. The technology eliminates nickel and associated environmental hazards and provides compelling cost savings for the F-35 and other aircraft platforms. The Air Force estimates a cost saving of $550 million across the life-cycle of the F-35 fleet alone. The technology has been developed and demonstrated in close collaboration with F-35 manufacturers, Northrop Grumman and Lockheed Martin and is now being used on F-35 aircraft.

Turbine Blade Health Monitoring Technology Lowers Sustainment Costs

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Blade Diagnostics Corp. (BDC)
Location: Pittsburgh, PA
2011 Air Force RIF / AF Propulsion Directorate (Start Date 9/21/12)
Title: *SmartBlend Extends Integrally Bladed Rotor Life*

Aircraft engines traditionally contained bladed disks that were constructed by inserting individual blades onto a central hub, and blades damaged in service could be replaced. Modern aircraft fans and compressors use a new single-piece design, called an Integrally Bladed Rotor (IBR). If an IBR is damaged beyond repair, the replacement costs are significant. Repairing a damaged IBR is an option but the method used increases the risk of failure from high cycle fatigue. To better inspect the IBR and verify the effectiveness of repairs, the Air Force RIF funded Blade Diagnostics Corporation (BDC) to develop the SmartBlend System. The System performs a virtual engine vibration test on IBRs and scans the edges of the blades to measure damage. The resulting data will determine whether IBRs can be repaired safely or should be replaced. The successful RIF project installed the BDC Smartblend System into the permanent IBR repair workflow at Tinker AFB, ALC Oklahoma City. According to an Air Force

spokesperson, "…Incorporation of this kind of technology in an aircraft repair cycle offers the potential for millions in cost-savings." This Air Force RIF project was derived from three prior Air Force SBIRs and a Navy STTR.

Helmet Sensors Record Blast Concussions for Treating mTBI

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Diversified Technical Systems (DTS)
Location: Seal Beach, CA
2011 Army RIF (Start Date 9/26/12)
Title: *SLICE 2.0*

Battlefield explosions, blunt impact and blast overpressure events can disrupt brain function through mild traumatic brain injuries (mTBI). These injuries can be treatable and most people who suffer mTBI concussions recover with no lasting effects, but the key is early detection and intervention. To analyze mTBI more effectively on the battlefield, the Army reached out to Diversified Technical Systems (DTS), Seal Beach, CA, to find a solution. Through funding from the Army RIF, and building upon prior Army SBIR efforts, DTS developed SLICE 2.0 from their SLICE line of standalone data loggers to help detect mild traumatic brain injuries in soldiers via a smart helmet sensor. Utilizing the SLICE 2.0 technology, DTS partnered with BAE in developing HEADS (Headborne Energy Analysis and Diagnostic Systems). HEADS is an ultra-small, helmet-mounted shock recorder that collects field data to help determine if a soldier should seek immediate medical attention for a possible mTBI. Nearly 50,000 units have been fielded by Army and Marine Corps Soldiers in Iraq and Afghanistan.

Army Technology Can Detect and Target Enemy Small Arms Fire

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Scientific Applications & Research Assoc., Inc. (SARA)
Location: Cypress, CA
2012 Army RIF / ERDC (Start Date 9/17/13)
Title: *Conformal Hostile Attack Detection System*

On the battlefield and in the air, it is critical to be able to identify, track and target incoming enemy small arms fire. Even if the enemy rounds are not an immediate threat, there is great urgency to quickly find and prosecute enemy attacks. To find a solution, the Army RIF funded Scientific Applications & Research Assoc., Inc. (SARA) in Cypress, CA, who collaborated with Orbital ATK to develop an acoustic hostile-fire warning system called the ShotFinder Acoustic Threat Warning System. Designed for use on

both rotary and fixed-wing aircraft, ShotFinder can detect the shock wave from a passing bullet and the muzzle blast from the weapon to determine a bullet's origin and point of closest approach. ShotFinder will pinpoint the location with a high probability of hostile-fire detection and a low false-alarm rate, and relay real-time directional warning to the pilot. This important RIF technology derived from a prior Army SBIR award to the company.

GMLRS Height of Burst Proximity Sensor Provides Enhanced Capability and Flexibility

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Technology Service Corp./Phase IV Systems Inc.
Location: Huntsville, AL
2013 Army RIF / AMC/RDECOM (Start Date 9/20/14)
Title: *Guided Multiple Rocket Launch System Enhanced Proximity Sensor*

The Army Guided Multiple Launch Rocket System (GMLRS) is a surface-to-surface system used to attack, neutralize, suppress, and destroy targets using indirect precision fires up to 70-plus kilometers. GMLRS munitions were utilized extensively in Operation Iraqi Freedom and Operation Enduring Freedom and continue to provide field artillery support in Overseas Contingency Operations. The munitions are particularly effective because of their greater accuracy and higher probability of kill with a reduced logistics footprint. The Army wanted to upgrade GMLRS with an affordable proximity sensor to detonate air bursts for precision missile strikes. With an award from the Army RIF, the Army tasked Technology Service Corp., through their Phase IV Systems subsidiary in Huntsville, AL, with finding a solution. The company developed an Enhanced Proximity Sensor (EPS) for GMLRS. Designed to provide a specific Height of Burst (HOB) for detonation of the rocket platform, EPS allows area type warheads to provide reliable effects on the choice target. The technology is now used on Lockheed Martin GMLRS systems.

USMC CAVEMAN Improves Safety and Saves Warfighter Lives

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Corvid Technologies, Inc.
Location: Mooresville, NC
2015 Navy RIF / USMC, DON Commander (Start Date 4/11/16)
Title: *Computational Anthropomorphic Virtual Experiment Man (CAVEMAN) Model for Injury Assessment in Kinetic Events*

In recent conflicts in both Iraq and Afghanistan, U.S. Warfighters have been attacked by enemy forces employing improvised explosive devices (IEDs). These IEDs accounted for 60% of coalition deaths in Iraq and 50% of coalition

causalities in the Afghanistan war (Wilson 2007). The Marine Corps, in response to the IED threat, has implemented Corvid Technologies' Computational Anthropomorphic Virtual Experiment Man (CAVEMAN) modeling technology for injury assessment in kinetic events. The technology contributes to survivability improvement efforts within the USMC vehicle community. CAVEMAN uses a virtual human body model for crew injury evaluation from underbody IED incidents. Corvid Technologies in Mooresville, NC, a subsidiary of Chickasaw Nations Industries received funding through the Army RIF to develop and support the CAVEMAN technology which built upon prior SBIR work by the company.

Navy GPS Anti-Jam Antenna Now Transitioned to the Army and Air Force

Modernization Priority: Fully Networked Command, Control, and Communications (FNC3)
NDS Pillar: Force Readiness and Lethality
Firm: Mayflower Communications Company, Inc.
Location: Bedford, MA
2013 Navy RIF / SPAWAR (Start Date 7/24/14)
Title: *Multi-platform Anti-jam GPS Navigation Antenna*

Satellite-based navigation using GPS (Global Positioning System) has become indispensable on the battlefield, and GPS-guided munitions are being used in ever increasing numbers. Unfortunately, reliance on GPS has become a growing vulnerability, with the first confirmed use of GPS-jamming equipment occurring during Operation Iraqi Freedom in 2003. GPS jamming by the enemy can cause precision-guided bombs to lose signal before they strike their target, which could be disastrous, while GPS jamming during operations in crowded shipping channels poses another level of threat. To counter the GPS jamming problem, the Navy RIF supported Mayflower Communications Company in developing GPS anti-jamming technology. Building upon their earlier Navy SBIR work, the company successfully developed the Multi-Platform Anti-Jam GPS Navigation Antenna (MAGNA) under the RIF. The MAGNA technology is now in use on Navy ships, on Army rotary wing, fixed wing and UAS aircraft, and on Air Force Special Operations Command aircraft.

Modular Refrigeration System (MRS) on Navy Ships Increases Efficiency and Cuts Costs

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Engineered Coil Company DBA DRS Marlo Coil (Leonardo DRS)
Location: High Ridge, MO
2015 Navy RIF/All Naval Programs (Start Date 6/24/16)
Title: *Modular Refrigeration System (MRS)*

The Navy, seeing a need for efficiency improvements and maintenance reductions in cooling and refrigeration systems on Navy ships, reached out to Leonardo DRS Marlo Heat Transfer Solutions near St. Louis, MO, to find a solution. With funding from the

Navy RIF, the company designed a 1.5 Ton (a measure of refrigeration equipment capacity) version of the Modular Refrigeration System (MRS) based on the 0.75 Ton MRS developed for the Navy's *Arleigh Burke* class (DDG 51) destroyers. The highly efficient refrigeration system incorporates self-contained diagnostic capabilities with a simple to use Human Machine Interface (HMI). The MRS replaced large outdated shipboard condensing units and coolers. According to the company, the MRS technology increases reliability ten-fold and decreases repair time up to 75%. It is now used on all active U.S. Navy nuclear-powered aircraft carriers (CVNs). In addition to the CVNs, MRS technology is now deployed on Navy DDG class destroyers. The technology is also in the process of transitioning to Navy LHA (landing helicopter assault) and LPD (landing platform dock) class ships.

Critical Weather Technology for Warfighter Safety

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Physical Optics Corporation/Intellisense Inc. (a wholly owned subsidiary)
Location: Torrance, CA
2016 Navy RIF / Marine Corps Systems Command (MCSC) (Start Date 6/28/17)
Title: *Micro Weather Sensor*

The U.S. Marine Corps (USMC) required an autonomous, self-contained micro weather sensor with a number of enhanced capabilities, including the ability to provide real-time meteorological conditions, including images of the surrounding area, in support of expeditionary operations globally in order to provide dominant battlespace situational awareness for key warfighting decisions. To fulfill this requirement, the USMC, via the Navy RIF, funded Physical Optics Corporation/Intellisense Inc. to develop a solar powered Micro Weather Sensor (MWS). The MWS technology is a low-cost, lightweight, ruggedized, portable weather station which can be deployed globally in remote locations either by hand or dropped by air to provide continuous, near realtime weather reports for aviation and airborne operations. The MWS is already in use by select Special Forces in the U.S. Africa Command (AFRICOM) area of operations. The MCSC RIF was a follow-on to an earlier SOCOM SBIR.

Navy Technology Helps the Warfighter Identify and Prosecute COMINT and Jamming Targets

Modernization Priority: Fully Networked Command, Control, and Communications (FNC3)
NDS Pillar: Force Readiness and Lethality
Firm: TICOM Geomatics, Inc. (now subsidiary of CACI International)
Location: Austin, TX
2011 Navy RIF / SPAWAR (Start Date 9/28/12)
Title: *SHIFTER Evolution*

Real-time precision geolocation of communications intelligence (COMINT) signals is a top priority in the global war on terror. The Navy and the larger Intelligence Community are aggressively deploying fully interoperable, net-centric systems for precision COMINT geolocation to help meet this challenge. To better enable this capability, the Navy RIF funded TICOM Geomatics of Austin, TX, to transition capabilities developed under prior Navy SBIR funding, demonstrating their SHIFTER processor on an operational network against multiple emitters. SHIFTER will "shift" the geolocation processing algorithms and processing hardware and software into the "high gear" needed to improve efficiency and scalability. With SHIFTER one can now simultaneously locate an emitter of interest and an interferer such as a jammer which improves the Warfighter capability to find, distinguish and target low power emitters for prosecution.

Detecting Counterfeit Electronic Parts on Military Aircraft

Modernization Priorities: Microelectronics, Cyber
NDS Pillar: Force Readiness and Lethality
Firm: Nokomis, Inc.
Location: Charleroi, PA
2011 Navy RIF / SSPO (Start Date 8/10/12)
Title: *Advanced Detection of Electronic Counterfeits*

Counterfeit electronics jeopardize the performance, reliability and safety of electronic systems, and can pose a potential "backdoor" cybersecurity threat to U.S. Military weapons systems. In 2012 a Senate Armed Services Committee (SASC) investigation discovered counterfeit electronic parts from China in the Air Force's largest cargo plane, in assemblies intended for Special Operations helicopters, and in a Navy surveillance plane. During the SASC investigation, 1,800 cases of bogus parts were identified. In response to this threat, the Navy selected Nokomis, Inc. for a Navy RIF award to develop the Advanced Detection of Electronic Counterfeits (ADEC) technology. All electronics parts radiate electromagnetic energy that is characteristic of the function, design, and construction of the part. The ADEC technology exploits these features. ADEC employs an ultra-sensitive Radio Frequency (RF) signature analyzer which is able to detect and automatically analyze signature footprints unique to a specific electronic part.

Anomalies within these signatures are used to detect counterfeit devices and prevent counterfeit parts from being integrated into U.S. Military weapon systems. Nokomis Inc. in Charleroi, PA, received funding from DoD SBIR and RIF programs in developing the ADEC technology.This RIF award was a formal Phase III derived from prior SBIR awards from the Army, Navy, Air Force and DTRA.

New Radiation Detection Technology Increases Capabilities without Helium-3

Modernization Priority: Nuclear
NDS Pillar: Force Readiness and Lethality
Firm: Radiation Monitoring Devices, Inc., a Dynasil company
Location: Watertown, MA
2016 OSD RIF / DTRA (Start Date 5/17/17)
Title: *Replacing High-Pressure He-3 Tubes*

The United States faces a very serious threat to our citizens and our Warfighters from terrorists trafficking components of a nuclear weapon into the country. Detecting illicit nuclear materials is critical to national security. Current technology for detecting neutrons found in nuclear materials such as highly enriched uranium and weapons grade plutonium utilizes the chemical element isotope helium-3, a byproduct of the U.S. nuclear weapons program. There is a problem however, helium-3 is extremely scarce and depleting rapidly. To tackle this problem, Radiation Monitoring Devices, Inc. (RMD) developed a portable solid-state radiation detector based on CLYC (Cs2LiYCl6). CLYC is an effective helium-3 substitute and has the ability to detect and discriminate both gamma rays and neutrons. Additionally, it is capable of high-resolution gamma ray spectroscopy, which provides very accurate identification of the radiation source. The DoD RIF provided the funding through the Defense Threat Reduction Agency (DTRA), after earlier support from the Domestic Nuclear Detection Office (DNDO) and the Department of Energy (DOE).

Hybrid Microgrid Provides Continuous Power in Cyberattack

Modernization Priorities: Cyber, General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Go Electric (a SAFT subsidiary)
Location: Anderson IN
2012 OSD RIF / NORTHCOM (Start Date 9/18/13)
Title: *Additional Generation and/or Storage for Cyber Secure Smart Grid*

The Pentagon has shown great interest in supporting research for microgrid systems that can guarantee bases and critical facilities stay online and operational in the event of an outage or cyberattack. In 2013, Go Electric of Anderson, IN, received RIF funding from NORTHCOM to demonstrate a 2-3 megawatt diesel powered generator and lithium ion

battery that seamlessly integrated with a cyber-secure microgrid. In a later 2017 RIF award, the DoD asked the company to further develop its AutoLYNC microgrid controller technology and develop a portable, modular, self-forming microgrid solution for the United States Africa Command (AFRICOM). The funding from the RIF enabled the company to develop a mobile microgrid which provides stable, clean power to forward operating units while maximizing fuel efficiency and providing enhanced reliable power. The hybrid system integrates power from the host nation's power grid, generators (fossil fuel and renewable), and energy storage to deliver clean, efficient, continuous power, even after cyberattack or other grid system failures.

Revolutionizing Forensic DNA Analysis

Modernization Priority: Biotechnology
NDS Pillar: Force Readiness and Lethality
Firm: Parabon Nanolabs, Inc.
Location: Reston, VA
2015 OSD RIF / RRTO (Start Date 9/26/16)
Title: *Bioinformatics Platform for Forensic Analysis*

In 2010, following repeated attacks on U.S. troops with improvised explosive devices (IEDs), the Defense Threat Reduction Agency (DTRA) sought DNA technologies that could provide information on the individuals who may have built or transported them. With funding from the DoD SBIR program, Parabon NanoLabs, Inc. had developed the Snapshot DNA Phenotyping capability, a system for predicting human physical traits from sample DNA and Snapshot Kinship Inference, which can determine the precise degree of relatedness between two or more DNA samples out to 6th-degree relatives (second cousins once removed). In 2015 these technologies were transitioned to law enforcement agencies where they, and a derivative service, Snapshot Genetic Genealogy, have proven effective in solving murder, sexual assault, and unidentified remains investigations. Parabon received a DoD Phase III contract under the Rapid Innovation Fund (RIF), through the Rapid Reaction Technology Office (RRTO), which was directly related to the Snapshot SBIR innovation. Initially, Parabon worked with the Armed Forces DNA Identification Laboratory (AFDIL) to customize the Snapshot Kinship Inference computer algorithms to enable them to be used on highly degraded DNA samples from unidentified soldiers. Under follow-on funding, Parabon developed the advanced DNA analysis platform, Parabon Fx which is capable of analyzing the full spectrum of current and emerging types of forensic DNA data (e.g., next generation sequencing).

Navy Technology Optimizes Maintenance of Ships

Modernization Priorities: Cyber, General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Mikros Systems Corp.
Location: Princeton, NJ
2012 Navy RIF / NAVSEA (Start Date 6/24/13)
Title: *Condition-Based Maintenance for Littoral Combat Ship (LCS)*

Navy Littoral Combat Ships (LCSs) are designed for missions in littoral waters close to shore. Their combat capability is dependent on the ship's "Total Ship Computing Environment," a maritime battle network linked by computers and sensors. To optimize ship operations, the Navy decided to implement a state-of-the-art Condition-Based Maintenance (CBM) system to monitor, detect, and predict performance problems. With funding from DoD SBIR and RIF programs, the Navy partnered with Mikros Systems Corp. (Princeton, NJ) to develop the AN/SYM-3 system for the LCS. SYM-3 provides cyber-secure remote status monitoring, enhanced secure networking and data analytics for the key components of the ship's Combat System, including sensors and weapons systems. Mikros is currently developing a new variant of the SYM-3 CBM system for two additional ship classes: Aircraft Carriers (CVN class) and Amphibious Assault Ships (LHD/LHA class).

Technology Delivers Reliable Position in GPS-Denied Environments

Modernization Priority: Fully Networked Command, Control, and Communications (FNC3)
NDS Pillar: Force Readiness and Lethality
Firm: TRX Systems, Inc.
Location: Greenbelt, MD
2013 Army RIF / AMC/RDECOM (Start Date 9/12/14)
Title: *Ground Soldier Embedded Training Enhancement*

Military capabilities rely heavily on GPS technology. US defense officials indicated GPS was a key factor in the successes of operations Desert Storm and Desert Shield. As the military became more reliant on GPS, that system became increasingly targeted by enemy combatants. In addition, interference from buildings, forest coverage, and other natural obstacles (such as caves) can disrupt GPS availability. As a result, warfighters are increasingly susceptible to GPS-denial. To counter the problem, the Army reached out to TRX Systems, Inc. (Greenbelt, MD) to find a solution. With funding from the DoD RIF, and building upon a prior Army SBIR, TRX developed the NEON® Personnel Tracker Solution, a low SWaP (Size, Weight and Power), assured PNT technology that provides 3D position and navigation capabilities when satellite technology is unavailable or unreliable. Integrated with the Android Team Awareness Kit (ATAK), NEON improves situational awareness where GPS is not available due to intentional GPS-interference or natural signal blockage. This technology is now being integrated into a Dismounted

Assured PNT System (DAPS) prototype in support of the Project Manager, Positioning, Navigation, and Timing (PM PNT).

Personal Cooling System Keeps CBRN Warfighters Safe

Modernization Priority: Fully Networked Command, Control, and Communications (FNC3)
NDS Pillar: Force Readiness and Lethality
Firm: RINI Technologies, Inc.
Location: Orlando, FL
2014 OSD RIF / JTSO/CBD (Start Date 8/17/15)
Title: *Personal Thermal Management System*

Clothing that protects Special Reaction Teams from chemical, biological, radiological and nuclear (CBRN) threats can subject the individuals to heat stress. These hazardous environments require the use of Personal Protective Equipment (PPE) with level A protection for several hours, which can diminish the body's ability to reject heat, leading to symptoms ranging from muscular weakness, dizziness, and physical discomfort to more severe, life-threatening conditions such as heat exhaustion or heat stroke. To find a solution and protect warfighters, the Defense Threat Reduction Agency (DTRA), with funding from the DoD RIF, partnered with RINI Technologies, Inc. (Orlando, FL) to develop a Personal Cooling System (PCS) for US Military CBRN suits that will provide heat-burden relief to the user. This RIF project helped to transition technology the company had originally developed under an earlier DARPA SBIR award. The PCS is a circulating liquid system that uses refrigeration to provide chilled water to a cooling vest. The cool water absorbs heat from the body, which is then released to the system's heat exchanger, maintaining the core body temperature of the user.

HMMWV Safety Features Provide Enhanced Stability and Cost Savings

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Ricardo Defense Systems, LLC
Location: Van Buren Township, MI
2016 Army RIF / PEOCSCSS (Start Date 4/19/17)
Title: *Antilock Braking System / Electronic Stability Control (ABS/ESC) for legacy HMMWV*

The High Mobility Multipurpose Wheeled Vehicle (HMMWV) saw widespread use in the Gulf War of 1991. During Phase I of Operation Iraqi Freedom in late 2003, the Marine Expeditionary Force began investing in new armor to protect Marines in HMMWVs against IEDs. Up-armor kits were soon developed for the HMMWV to improve ballistic protection and resistance to mine blast. The additional armor added about 2,000 pounds more than the standard HMMWV. The added weight of the armor changed the

HMMWV's center of gravity, which made the vehicle unstable and harder to control and more prone to rollovers. To resolve the problem, the Army, with funding from the DoD RIF, partnered with Ricardo Defense Systems LLC (Van Buren Township, MI) to develop HMMWV Antilock Braking System/ Electronic Stability Control (ABS/ESC) technology. In addition to mitigating rollovers, the technology also improves brake life which could potentially save the Army $15K over a vehicle's lifetime.

Mission Critical Cloud Analytics Collaboration

Modernization Priority: Fully Networked Command, Control, and Communications (FNC3)
NDS Pillar: Force Readiness and Lethality
Firm: EOIR Technologies, Inc./Parsons Corporation
Location: Fredericksburg, VA
2011 Army RIF (Start Date 9/10/12)
Title: *Cloud Analytics Collaboration Environment (CACE)*

Staying informed of rapidly changing, critical intelligence is key to maintaining a definitive advantage in today's security and defense environments. Interaction and collaboration between units and agencies needs to be faster than ever, ensuring that the right people get the right data as soon as possible for guaranteed mission success. However, to communicate changes in real time between Intelligence and Operations, the user interface platform used by both communities must be standardized as well as dynamic to meet the needs of not only individual analysts but community-specific requirements. To find a solution, the Army, with funding from the DoD RIF, partnered with EOIR Technologies, Inc. (now part of Parsons Corp.) to develop the Cloud Analytics Collaboration Environment (CACE) system. CACE provides analysts with the tools and capabilities needed in a browser-based, user-friendly solution for collaborating and solving problems in real time. Its dashboard-style interface is secure, customizable, scalable, and open standards-based.

Neurowave Monitors EEG for TBI and Critical Care Anesthesia

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Neurowave Systems Inc.
Location: Cleveland Heights, OH
2011 Army RIF (Start Date 9/24/12)
Title: *Battlefield Seizure Detector for TBI Assessment (SeizTBI)*

With funding provided by the Army through the DoD RIF, Neurowave Systems Inc. (Cleveland Heights, OH) built upon their prior work under an Army SBIR to develop a miniaturized, integrated EEG monitor to assess the brain function of war casualties directly at the point of injury in order to screen for Traumatic Brain Injury (TBI). In

2014, NeuroWave received an FDA 510k clearance for the DiscoverEEG (DE-401), which was directly based on the technology developed under the RIF. Using the EEG acquisition technology developed through the RIF, NeuroWave is currently developing a platform to provide sedation relief during En-Route Care (AutoSED) for the US Navy. AutoSED measures brain activity through the miniaturized EEG monitor, and adjusts the delivery of intravenous drugs in an automated fashion, akin to an auto-pilot for the brain. This technology could potentially enable the safe transport of casualties in autonomous vehicles, as well as prolonged field care. The technology could also play an important role to help manage sedation in civilian mass casualty scenarios, such as with COVID-19 where many patients had to be ventilated and kept sedated for extensive periods of time in a resource constrained environment.

Redesigned Air Force 463L Pallets are Cost Effective and 100% Recyclable

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Business Reform
Organization: University of Dayton Research Institute (UDRI)
Location: Dayton, OH
2013 Air Force RIF / AFTC (Start Date 8/5/14)
Title: *Innovative Manufacturing of All-Aluminum 463L Cargo Pallet*

The 463L Master Pallet is a standardized pallet used for transporting military air cargo. It is the main air-cargo pallet of the United States Air Force, designed to be loaded and offloaded on today's military airlifters as well as many civilian Civil Reserve Air Fleet (CRAF) cargo aircraft. The current 463L pallet design is nearly 50 years old with balsa wood inserts and costs nearly as much to refurbish as it does to replace. In 2014, the Air Force partnered with the University of Dayton Research Institute (UDRI), Dayton, OH to develop the 463L next-generation, low-cost, fully recyclable, cargo pallet for use in the C-130 Hercules, C-17 Globemaster and C-5 Galaxy aircraft. The redesigned pallet will have twice the service life with half of the yearly costs and feature all-aluminum construction. The pallet will also be 100% recyclable and will have no adhesive in the design, which creates a hazardous waste stream.

Planning Software Helps Military Planners Execute Complex Missions on the Fly

Modernization Priority: Fully Networked Command, Control, and Communications (FNC3)
NDS Pillar: Force Readiness and Lethality
Firm: Monterey Technologies, Inc.
Location: Park City, UT
2011 Navy RIF / NAVAIR (Start Date 7/9/12)
Title: *Navy Multi-Echelon Mission Planning*

Military tactical and operational planning requires extensive analysis of navigation, operations, weapons, platform capabilities and limitations, and logistics. Navigation charts and environmental data, such as weather forecasts, need to be studied in detail. In planning for complex operations, objectives must be established, and air, surface, and subsurface platforms' courses and maneuvers must be developed to meet these military objectives while limiting collateral effects. The Navy realized there was a significant "time to plan" issue for military operations and contracted with Monterey Technologies, Inc. (MTI), Park City, UT to develop a way to solve this time to plan problem. With a Navy RIF award that built upon their previous Navy SBIR work, the company developed the ViPER (Visual Planning Execution and Review) mission planning tool. ViPER provides a collaborative electronic planning environment that enables electronic planning across multiple different platforms and domains, and automatically generates planning products that formerly took hours to days to prepare. ViPER now serves as the desktop for Navy planning teams and provides the ability to bring in all authoritative data sources (e.g. intelligence, weather, etc.) necessary to create effective plans. Versions of ViPER are now fielded on all US Navy, British Navy and Australian Navy submarines where ViPER is fully integrated with the BYG-1 submarine combat system, and on all US aircraft carriers where ViPER is integrated as a federated application in the F-18 JMPS (Joint Mission Planning System). MTI is currently building a new prototype version of ViPER for the US Army Airborne.

GNOME ECU Expands the Military Utility of Small Satellites

Modernization Priorities: Fully Networked Command, Control, and Communications (FNC3); Space
NDS Pillar: Force Readiness and Lethality
Firm: Innoflight, Inc.
Location: San Diego, CA
2013 Air Force RIF / PEO BES (Start Date 9/15/14)
Title: *Type 1 Certified CubeSat Communications*

The military utility of Small Satellites has been limited because: (a) traditional space Communications Security (COMSEC) End Cryptographic Units (ECUs) are I/O resource intensive to integrate into a spacecraft bus; and (b) the flight COMSEC units are

pre-loaded with mission keys and subsequently require assembly, integration and test (AI&T) conducted at the classification level of these keys. To eliminate these limitations, the Air Force RIF funded Innoflight (San Diego, CA) to develop a cost-effective technology for secure space-to-ground or space-to-space communications that could prevent non-authorized entities from intercepting Telemetry, Tracking and Command (TT&C) and mission critical data. This RIF project was a follow-on to a previous Air Force SBIR contract for the company. The resulting technology, KI-103 End Cryptographic Unit (ECU), is also known as GNOME, and in 2019 was NSA-certified for Top Secret and Below (TSAB) missions and successfully flew on-orbit. GNOME includes additional onboard processing providing agile serial interfaces to ease the integration with a variety of spacecraft busses and radios, including Innoflight's own Software-defined Compact Radios. Also, as a first for space COMSEC, GNOME supports external key loading allowing AI&T to be conducted using unclassified test keys and then mission keys loaded after AI&T is complete.

BrainScope Applies AI for On-Site TBI Assessment

Modernization Priorities: Artificial Intelligence (AI); General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: BrainScope, Inc.
Location: Bethesda , MD
2011 Army RIF (Start Date 9/20/12)
Title: *Miniature Field Deployable System for Rapid TBI Screening*
2013 Army RIF / MRMC (Start Date 9/24/14)
Title: *Validation of Point-of-Care Traumatic Brain Injury (TBI) Detention*

As witnessed by the recent missile attacks on Al Asad Air Base in Iraq, traumatic brain injury (TBI) is a significant medical issue which affects brain health of service members. The high rate of TBI and blast-related concussion events resulting from combat and training operations directly impacts the health and safety of individual service members and subsequently the level of unit readiness and troop retention. Current tools to diagnose TBI are lacking in many ways. CAT scans are the current standard of care for detection of structural brain injury, TBI (brain bleeds), but CT machines are not always accessible at military sites and emit significant amounts of radiation. Tools to assess functional or mild TBI (mTBI/concussions) are largely subjective, symptoms-based, and can be gamed. In order to address longstanding limitations of available tools, the Army, with funding from the DoD RIF, partnered with BrainScope Company, Inc., Bethesda, MD to transition its technology onto a ruggedized, handheld point-of-care device. BrainScope One is a ruggedized, handheld, point-of-care, multi-modal device that has achieved 8 FDA clearances for its objective biomarkers that aid in the assessment of structural and functional brain injuries and can be used to baseline, assess acute injury and follow-up and inform mTBI diagnoses and return to duty decisions. Using artificial intelligence and machine learning and leveraging advanced signal processing of brain electrical activity, BrainScope One identifies markers of those likely to have

brain bleeds as well as those who are likely concussed. Testing takes as little as 10 minutes and results are available in real-time in a non-invasive and non-radiation emitting device. The device also incorporates a digitized version of the Military Acute Concussion Evaluation 2 (MACE2) currently used within the military.

Navy UAV Recon Helps Ensure Warfighter Safety in Littoral Battlespace

Modernization Priorities: Autonomy; General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Arete Associates
Location: Northridge, CA
2011 Navy RIF / NAVSEA (Start Date 8/13/12)
Title: *Real-time Drifting Mine Detection on COBRA*

Mines present a significant threat on land, the beach and in waters shallower than 300 feet. This littoral region is where the greatest number of mines are most effective and where power projection missions require that U.S. forces operate. Coastal Battlefield Reconnaissance and Analysis (COBRA) system operators could not execute in-situ Minefield Detection (MFD) and Near-Surface Naval Mine Detection (NSNMD) from the MQ-8B Fire Scout. To find a solution, the Navy RIF funded Arete Associates, under a Phase III SBIR contract that completed and transitioned prior Navy SBIR work, to develop multispectral unmanned vehicle sensor payloads for mine detection for the Navy COBRA system to support the littoral combat ship (LCS) mine countermeasures mission. The technology provides real time detection of near surface sea mines and beach zone mine lines by Unmanned Aerial Vehicle (UAV) sensor suites, resulting in timely reconnaissance data and eliminating the need for post mission analysis stations. MFD timelines are reduced from many hours to minutes, and NSNMD capability can provide real-time detection and tracking of naval mines enabling in-situ prosecution.

Adaptive Ventilation for Closed Air Environments Reduces Costs and Saves Lives

Modernization Priority: General Warfighting Requirements (GWR)
NDS Pillar: Force Readiness and Lethality
Firm: Figure Engineering
Location: Manassas Park, VA
2016 Air Force RIF / PEO Space (Start Date 8/3/17)
Title: *Advanced Continuous-Time Adaptive Ventilation (ACTAV)*

When workers are involved in welding, removing corrosion, blasting off old paint and repainting aircraft, they are frequently exposed to toxic hexavalent chromium (Cr+6), which is 8x more carcinogenic than asbestos. Conventional

abatement technologies to control exposure included blast cleaning rooms (BCR) which use airflow to reduce exposure. Simply increasing airflow to reduce exposure is an expensive proposition, however. Energy costs increase exponentially when fixed parameter airflow is used to mitigate airborne toxin exposure. To find a solution, the Air Force RIF funded Figure Engineering through a Phase III contract that supported the transition of an earlier Air Force SBIR award. As a result, the company developed three critical technologies: the Advanced Continuous-Time Adaptive Ventilation (ACTAV™) for Closed Air Environments, the Continuous Hazardous Environment Monitor (CHEM) sensor for real-time chromium and cadmium measurement, and Dust Migration Mapping (DMM). The technologies reduce airborne toxin exposure while maintaining reasonable BCR operating cost by detecting airborne toxins and comparing them to known hazardous limits to enact an autonomous ventilation system response. With the addition of Figure's Dust Migration Mapping™ technology, diagnostic validation is employed to support routine monitoring for safety and compliance.