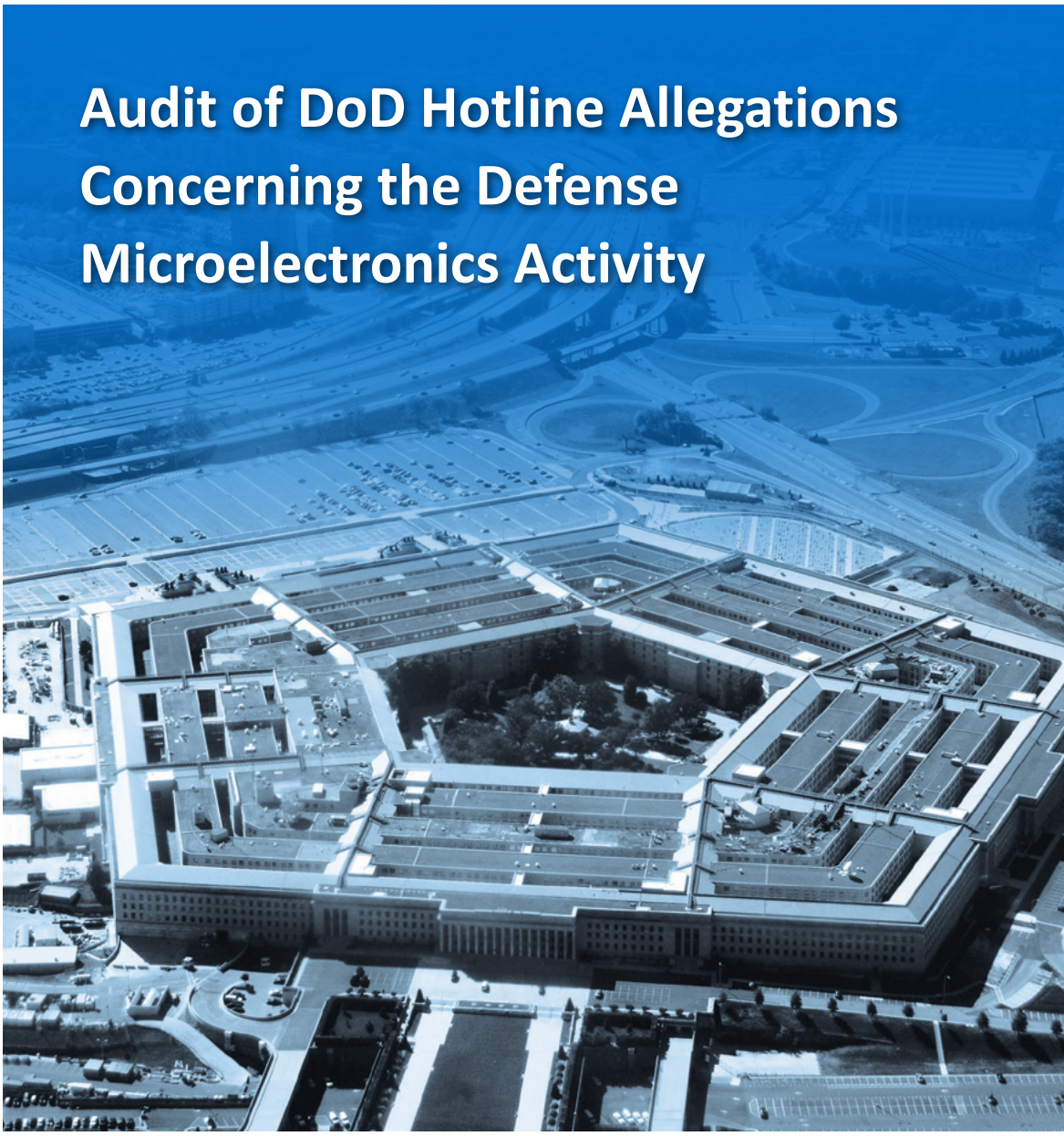
Report No. DODIG-2020-072

INSPECTOR GENERAL

U.S. Department of Defense

MARCH 24, 2020

Audit of DoD Hotline Allegations Concerning the Defense Microelectronics Activity



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Results in Brief

Audit of DoD Hotline Allegations Concerning the Defense Microelectronics Activity

March 24, 2020

Objective

We conducted this audit in response to allegations made to the DoD Hotline. The objective of this audit was to determine whether the Defense Microelectronics Activity (DMEA) resolved customer requests for microelectronics using the Advanced Reconfigurable Manufacturing for Semiconductors (ARMS) facilities.

Background

The DoD Hotline received an allegation that the DMEA was not capable of performing one aspect of its mission to manufacture integrated circuit chips (chips) that were not commercially available for DoD weapon systems.[1] The allegation also stated that the DMEA received requests to design and manufacture tens of thousands of obsolete chips needed to keep DoD weapon systems operational. The allegation stated that of the thousands of obsolete chips, the DMEA had fielded only five chips that were manufactured in the ARMS foundry.

The DMEA was established in 1997 to be the DoD center for microelectronics technology, acquisition, transformation, and support. The DMEA provides microelectronics components, assemblies, and expertise in support of DoD systems. The Director of Defense Research and Engineering for Research and Technology oversees all DoD research and technology investments, including the DMEA.

[1] Integrated circuit chips are interchangeable with the terms microchip, chip, and semiconductor. These terms refer to a microscopic array of electronic circuits built on top of a piece of semiconductor material, such as silicon.

Background (cont'd)

The ARMS facilities include the ARMS foundry and other ARMS labs, such as the Science and Engineering Gamma Irradiation Test Lab, for radiation testing; the Packaging and Assembly Substrate Lab, for cutting and packaging wafers and for producing higher-level assemblies, such as circuit boards; and labs for conducting assurance and forensic activities, reliability testing, and other device testing.

The ARMS foundry became operational in November 2003 and, with the other ARMS labs, takes silicon starting material and produces chips to support existing DoD weapon systems. The end product of the ARMS foundry is wafers. According to a DMEA official, a wafer begins as a disc of silicon, upon which semiconductor materials are deposited in sequence to create the necessary circuit pattern. The DMEA can produce a single wafer or groups of wafers, called lots. The DMEA's Packaging and Assembly Substrate Lab cuts the wafers into pieces, called die, that each contain one copy of the circuit, and then packages the die in cases to prevent physical damage and corrosion. A packaged die is a chip.

DoD program managers, DoD technology and engineering personnel, officials from other Government agencies, and Defense industry personnel (customers) can request microelectronic solutions from the DMEA. DMEA solutions range from simple device replacement, system redesign, or redesign of an obsolete chip, to testing a chip for operating effectiveness, reliability, or authenticity. Between January 1, 2014, and June 30, 2019, the DMEA received 1,592 customer requests. Of the 1,592 customer requests, 908 (57 percent) were from the Military Services and other DoD agency customers and the remaining requests were from other Government agencies (14 percent) and non-Government entities (29 percent).

Results in Brief

Audit of DoD Hotline Allegations Concerning the Defense Microelectronics Activity

Finding

The DMEA generally resolved customer requests for microelectronics using the ARMS facilities. Specifically, the DMEA identified solutions for 882 of the 908 DoD requests (97 percent) that did not require the use of the ARMS foundry. In addition, between January 1, 2014, and June 30, 2019, the DMEA used the ARMS foundry to fabricate five wafer lots for five DoD customer requests. The DMEA was unable to provide solutions for 10 DoD requests because of a lack of technical data or a lack of DMEA engineering resources or processes to provide a solution. Furthermore, 11 DoD customers did not pursue a DMEA solution because the customer identified its own solution or the customer did not respond to DMEA followup requests.

While the DMEA was able to resolve the majority of customer requests, it is not clear whether the DoD's current use of the ARMS foundry is justified. The DMEA spent $32.4 million between January 1, 2014, and June 30, 2019, to maintain the ARMS foundry while using it to address only 5 DoD customer requests. The DMEA also budgeted $35.8 million to maintain the ARMS foundry from July 1, 2019, through June 30, 2024.

Recommendations

We recommend that the Director of Defense Research and Engineering for Research and Technology, Office of the Under Secretary of Defense for Research and Engineering, complete an assessment of the use of the existing foundry and determine whether the existing foundry is still needed.

Management Comments and Our Response

The Acting Director of Defense Research and Engineering for Research and Technology, Office of the Under Secretary of Defense for Research and Engineering, agreed with our recommendation and stated that she will conduct the assessment. Comments from the Acting Director addressed the specifics of the recommendation because the Acting Director will conduct the recommended assessment; therefore, the recommendation is resolved but will remain open. We will close the recommendation once the Office of the Under Secretary of Defense for Research and Engineering provides documentation to verify that an assessment of the use of the existing foundry was completed and a determination was made regarding whether the existing foundry is still needed.

Recommendations Table

Management	Recommendations Unresolved	Recommendations Resolved	Recommendations Closed
Office of the Under Secretary of Defense for Research and Engineering	None	1	None

Note: The following categories are used to describe agency management's comments to individual recommendations.

- **Unresolved** – Management has not agreed to implement the recommendation or has not proposed actions that will address the recommendation.
- **Resolved** – Management agreed to implement the recommendation or has proposed actions that will address the underlying finding that generated the recommendation.
- **Closed** – OIG verified that the agreed upon corrective actions were implemented.


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March 24, 2020

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

SUBJECT: Audit of DoD Hotline Allegations Concerning the Defense Microelectronics Activity (Report No. DODIG-2020-072)

This final report provides the results of the DoD Office of Inspector General's audit. We previously provided copies of the draft report and requested written comments on the recommendations. We considered management's comments on the draft report when preparing the final report. These comments are included in the report.

The Acting Director of Defense Research and Engineering for Research and Technology, Office of the Under Secretary of Defense for Research and Engineering, agreed to address the recommendation presented in the report; therefore, the recommendation is considered resolved and open. As described in the Recommendations, Management Comments, and Our Response section of this report, the recommendation may be closed when we receive adequate documentation showing that all agreed-upon actions to implement the recommendation have been completed. Therefore, please provide us within 90 days your response concerning specific actions in process or completed on the recommendation. Your response should be sent to either followup@dodig.mil if unclassified or rfunet@dodig.smil.mil if classified SECRET.

If you have any questions, please contact me at [redacted].

Theresa S. Hull
Assistant Inspector General for Audit
Acquisition, Contracting, and Sustainment

Contents

Introduction

Objective

We conducted this audit in response to allegations made to the DoD Hotline. The objective of this audit was to determine whether the Defense Microelectronics Activity (DMEA) resolved customer requests for microelectronics using the Advanced Reconfigurable Manufacturing for Semiconductors (ARMS) facilities. See the Appendix for a discussion of the scope and methodology related to the audit objective.

Background

The DoD Hotline received an allegation that the DMEA was not capable of performing one aspect of its mission to manufacture integrated circuit chips (chips) that were not commercially available for DoD weapon systems.[2] The allegation also stated that the DMEA received requests to design and manufacture tens of thousands of obsolete chips needed to keep DoD weapon systems operational. The allegation stated that of the thousands of obsolete chips, the DMEA had fielded only five chips that were manufactured in the ARMS foundry.

The ARMS facilities include the ARMS foundry and other ARMS labs. The ARMS foundry became operational in November 2003. The foundry, with the other ARMS labs, takes silicon starting material and produces chips to support existing DoD weapon systems. The other ARMS labs are the Science and Engineering Gamma Irradiation Test Lab, for radiation testing; the Packaging and Assembly Substrate Lab, for cutting and packaging wafers and for producing higher-level assemblies, such as circuit boards; and labs for conducting assurance and forensic activities, reliability testing, and other device testing. The allegation states that the DMEA's inability to design and manufacture chips constituted a severe shortfall in national defense.

Defense Microelectronics Activity

On March 23, 1997, the DMEA was established to be the DoD center for microelectronics technology, acquisition, transformation, and support. The DMEA provides microelectronics components, assemblies, and expertise in support of DoD systems. The DoD must have a supply chain for 20 or more years to maintain DoD legacy systems. However, in as little as 2 years after the systems are purchased, components may no longer be available from commercial companies. In addition,

[2] Integrated circuit chips are interchangeable with the terms microchip, chip, and semiconductor. These terms refer to a microscopic array of electronic circuits built on top of a piece of semiconductor material, such as silicon.

the DMEA was established to ensure a long-term trusted, assured, and secured supply of microelectronics for DoD chip requirements. The DMEA supports the Military Services, along with the Department of Homeland Security, Department of Energy, Department of Transportation, Department of Justice, as well as many Defense contractors and international programs with the United Kingdom and other allied countries.

The Office of the Under Secretary of Defense for Research and Engineering (OUSD[R&E]) serves as the principal adviser to the Secretary of Defense on all research, engineering, and technology development activities and programs in the DoD. The OUSD(R&E) establishes policies on the DoD's research and engineering, technology development, technology transition, prototyping, experimentation, and developmental testing activities and programs. The Under Secretary of Defense for Research and Engineering designated microelectronics as a modernization priority. The Director of Defense Research and Engineering for Research and Technology serves as the principal adviser to the OUSD(R&E) on all the DoD's research and technology investments, including the DMEA.

DMEA Chip Manufacturing Process

The fabrication of a chip involves multiple processing steps to manufacture and connect many transistors and other circuit components to form the desired circuit function. Each type of chip requires a different process, and the processes evolve as microelectronic parts get smaller and more powerful. Figure 1 shows the six phases in the DMEA chip manufacturing process.

Figure 1. DMEA Chip Manufacturing Phases

Source: The DMEA.

During the design phase, the DMEA develops the design files, including the fabrication process and tools needed to make the chip. During the aggregate phase, the DMEA then incorporates multiple designs into a graphic file that produces a mask. A mask is a glass plate that contains holes to allow light in certain areas, while blocking light in other areas, to create distinctive patterns on silicon or sapphire. The DMEA contracts with a commercial company to manufacture the masks. During the foundry phase, the ARMS foundry applies masks to thin round slices of silicon or sapphire called wafers. The end product of the ARMS foundry is wafers. According to a DMEA official, a wafer begins as a disc of silicon, upon which semiconductor materials are deposited in sequence to create

the necessary circuit pattern. The DMEA can produce a single wafer or groups of wafers, called lots. The DMEA's Packaging and Assembly Substrate Lab cuts the wafers into pieces, called die, that each contain one copy of the circuit, and packages the die in cases to prevent physical damage and corrosion. A packaged die is a chip. The Packaging and Assembly Substrate Lab then builds higher-level assemblies, such as circuit boards, with multiple packaged chips. During the test phase, the DMEA confirms that a chip or higher-level assembly meets design and manufacturing requirements through rigid and repeatable exercises and evaluations. Once a chip or assembly passes all tests, the DMEA delivers it to the end user for fielding. Figure 2 shows a wafer, die, and chip package.

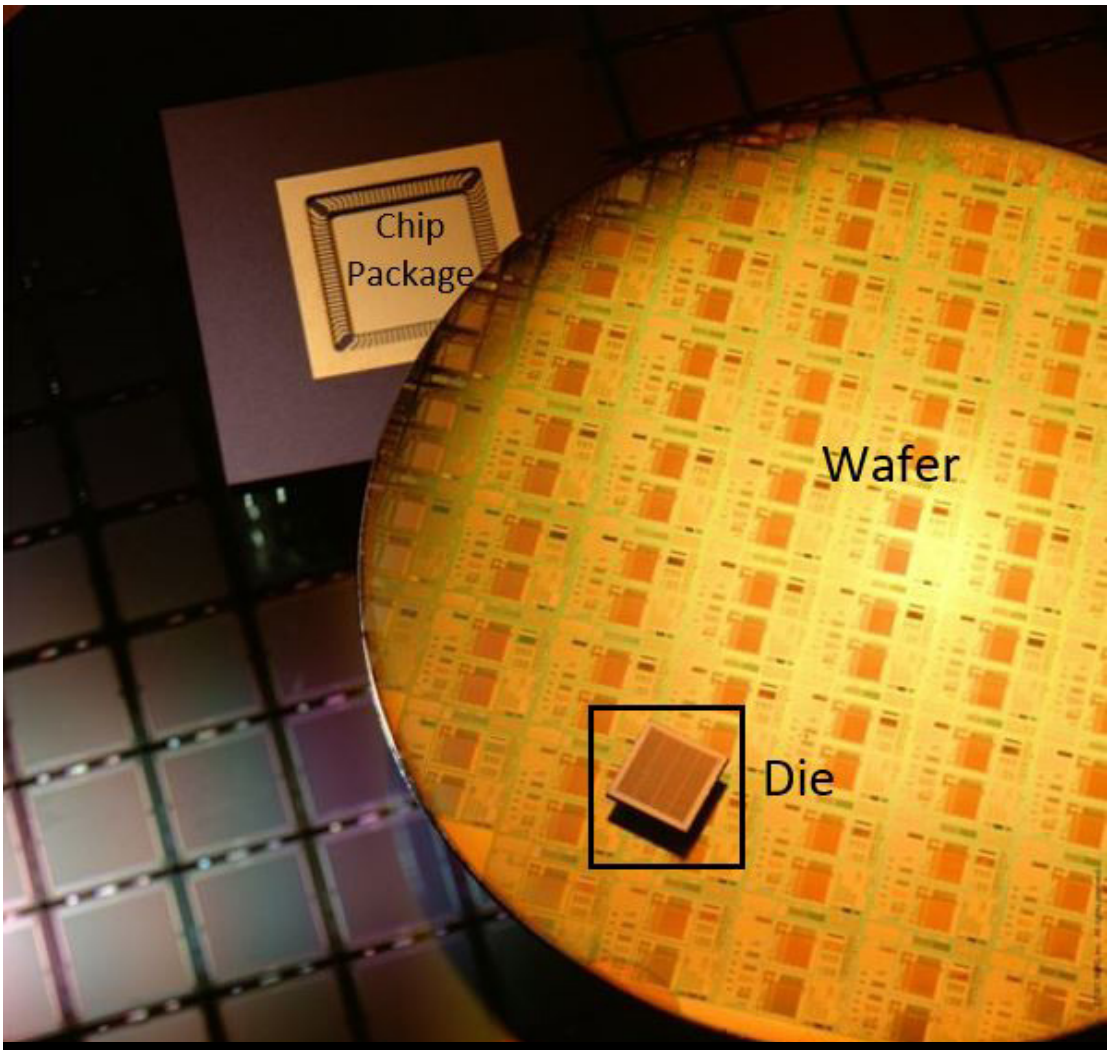


Figure 2. Wafer, Die, and Chip Package
Source: The DMEA.

DMEA Solutions for Customers

DoD program managers, DoD technology and engineering personnel, officials from other Government agencies, and Defense industry personnel (customers) can request microelectronic solutions from the DMEA. DMEA solutions range from simple device replacement, system redesign, or redesign of an obsolete chip, to testing a chip for operating effectiveness, reliability, or authenticity.

When the DMEA receives a customer request for assistance, the DMEA first tries to identify any existing stock or a suitable substitute for a weapon system. If the DMEA identifies a source, it provides the customer's request to a commercial supplier. There are 77 accredited commercial suppliers within the United States. According to a DMEA official, these suppliers include large Defense contractors, small microelectronics companies, and the DMEA (accredited by the National Security Agency).

If the DMEA cannot find any existing stock or a suitable substitute, the DMEA analyzes the problem and identifies a solution. The DMEA researches the technical information associated with the microelectronic and identifies any applicable standards. If necessary, the DMEA will reverse engineer the device to recreate vital missing data. The DMEA develops a business case analysis by providing short-and long-term solutions to the customer. The customer chooses the best solution for the program's schedule and resources.

According to a DMEA official, if the DMEA identifies that the accredited suppliers can manufacture the chip, the DMEA directs the customer to the authorized suppliers. If the customer requires more complex and direct microelectronics support, such as redesign or integration into a higher assembly, the DMEA uses the Advanced Technology Support Program (ATSP) contract or DMEA internal capabilities, as appropriate. The ATSP contract is an indefinite-delivery indefinite-quantity contract with a $7.2 billion ceiling over a base term of 2 years, and four 2-year options. Indefinite-delivery indefinite-quantity contracts provide for an indefinite quantity of supplies or services during a fixed period. The ATSP contract tasks include:

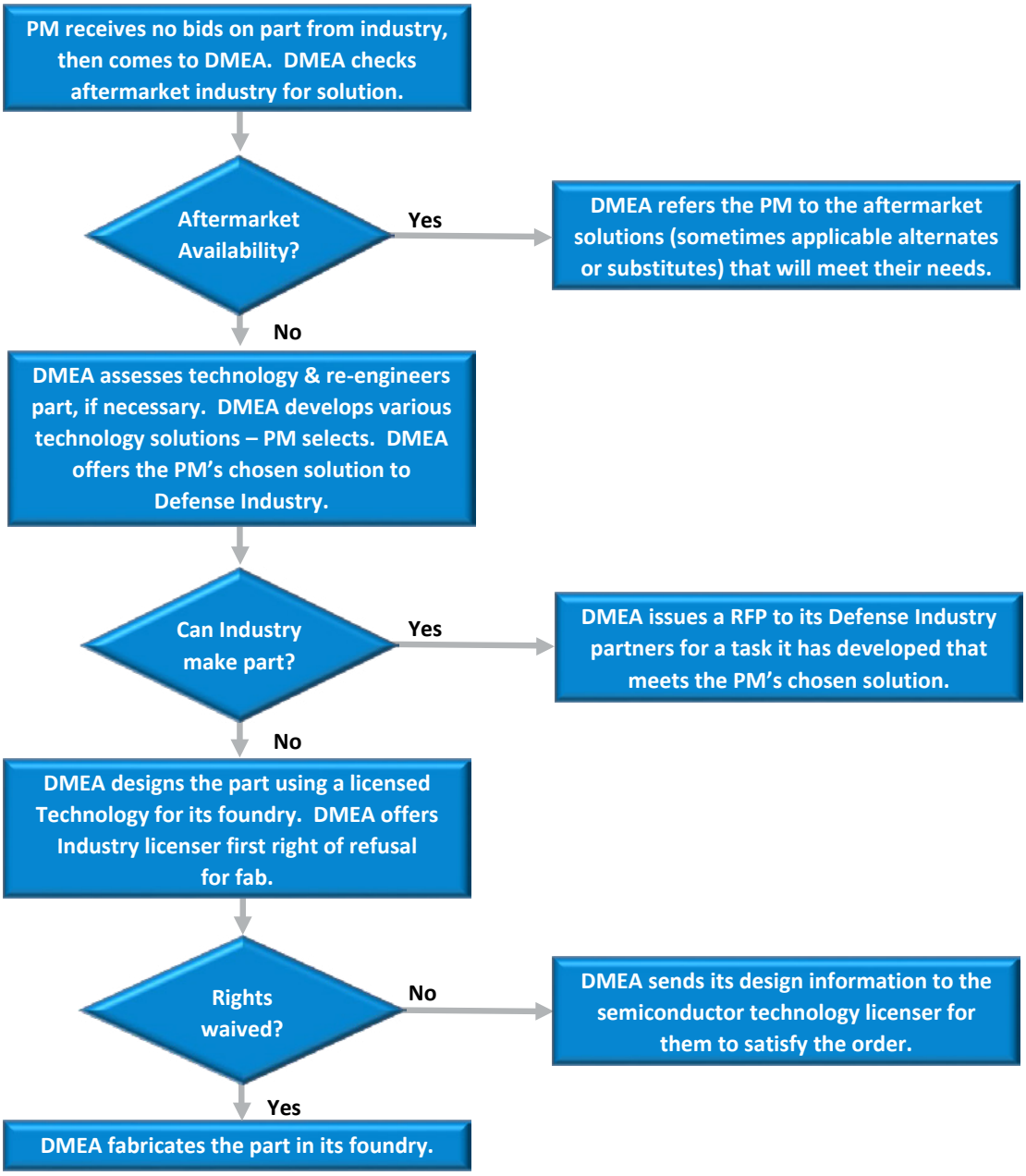
- systems engineering, trade studies, technology assessment;
- software design, analysis, coding, testing and verification; and
- hardware design, fabrication, assembly, testing, integration, prototyping and limited production of electronics, chips, electro-optics, printed circuit boards and modules, and systems and subsystems.

The DMEA provides a project engineer for each task to assist the customer through the engineering and contracting process. A contract solicitation is issued to the ATSP contractor to manufacture the chip.

The DMEA can also provide the customer access to commercial state-of-the-art foundries through a contract with GLOBALFOUNDRIES. GLOBALFOUNDRIES maintains domestic facilities that provide advanced microelectronics parts capabilities to the Government and can manufacture chips in high volume. The current contract provides access to GLOBALFOUNDRIES through FY 2023. This resource is made available for Government use only and therefore access requests require a valid Government sponsor.

If the DMEA cannot fulfill the requirement through a supplier, the DMEA designs the chip using the ARMS facilities. The DMEA first offers the original manufacturer the opportunity to manufacture the chips by providing design information to satisfy the order. If the original manufacturer declines to manufacture the chips, the DMEA assesses if it can fabricate the chips using the ARMS facilities, including the foundry. Figure 3 shows the DMEA process for providing solutions to customers.

Figure 3. DMEA Process for Providing Solutions to Customers



Source: The DMEA.

In addition to providing solutions to customer requests, the DMEA is the overall program manager for the Trusted Foundry Program. The DMEA serves as the Government accreditation authority and accredits companies to be in the Trusted Foundry Program. The trusted companies are those that have been vetted and are capable of assuring a proper chain of custody, preventing reasonable threats to the supply chain, preventing modification or tampering of chips, and protecting chips from being copied or released. Since January 1, 2014, the DMEA has accredited 90 suppliers.

The DMEA also coordinates with the Government, the Defense industry, and academia on research projects. The DMEA has 138 cooperative research and development agreements with Government agencies and large and small companies to facilitate technology transfer between other Government agencies, the Defense industry, and colleges and universities.

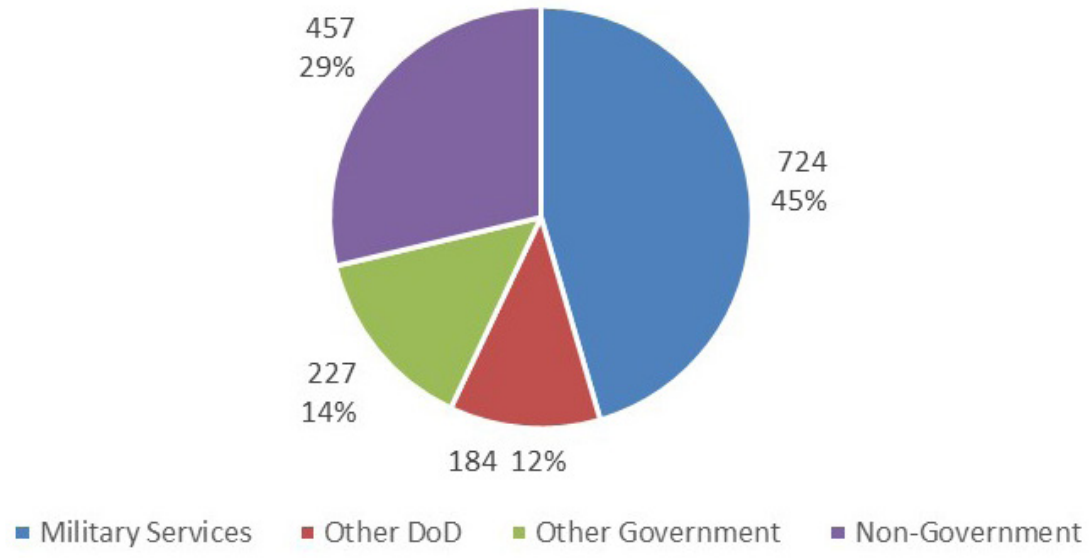
DMEA Customer Requests

Between January 1, 2014, and June 30, 2019, the DMEA received 1,592 customer requests. Of the 1,592 customer requests:

- 724 (45 percent) were from the Military Services;
- 184 (12 percent) were from other DoD agencies, including the Office of the Secretary of Defense and National Geospatial-Intelligence Agency;
- 227 (14 percent) were from other Government agencies, including the Department of Energy and the National Aeronautics and Space Administration; and
- 457 (29 percent) were from non-Government entities, including Defense contractors and universities.

Figure 4 shows the customer requests categorized by customer type.

Figure 4. Customer Requests Received by the DMEA by Customer Type



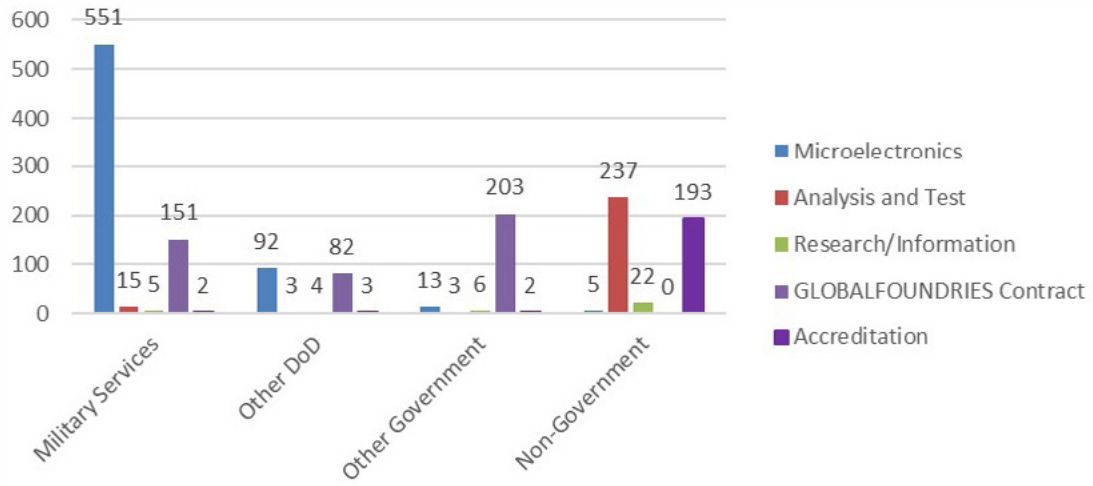
Source: The DoD OIG.

Of the 1,592 customer requests, 908 were from the Military Services and other DoD agencies. Specifically, the Military Services and other DoD agencies requested the DMEA to provide:

- 643 solutions for problems with microelectronics, including chips, circuit cards, prototype units, printed circuit boards, and production units with data packages;
- 233 solutions for access to the GLOBALFOUNDRIES contract to design, manufacture, and distribute state-of-the-art chips;
- 18 solutions for analysis and test that measured the operating effectiveness and reliability of microelectronics;
- 9 solutions for research and information for DMEA opinions, guidance, and collaborative research; and
- 5 solutions for accreditation to become a trusted source.

The other Government customers primarily requested access to the GLOBALFOUNDRIES contract and the non-Government customers primarily requested analysis and test on microelectronics and accreditations to become a trusted source. Figure 5 illustrates the type of customer requests received by the DMEA.

Figure 5. Type of Customer Requests Received by the DMEA



Source: The DoD OIG.

Review of Internal Controls

DoD Instruction 5010.40 requires DoD organizations to implement a comprehensive system of internal controls that provides reasonable assurance that programs are operating as intended and to evaluate the effectiveness of the controls.[3] The DMEA's internal controls related to the ARMS facilities were effective as they applied to the audit objectives.

[3] DoD Instruction 5010.40, "Managers' Internal Control Program Procedures," May 30, 2013.

Finding

The DMEA Fabricated Five Solutions in the ARMS Foundry

The DMEA generally resolved customer requests for microelectronics using the ARMS facilities. Specifically, the DMEA identified solutions for 882 of the 908 DoD requests (97 percent) that did not require the use of the ARMS foundry. In addition, between January 1, 2014, and June 30, 2019, the DMEA used the ARMS foundry to fabricate five wafer lots for five DoD customer requests. The DMEA was unable to provide solutions for 10 DoD requests because of a lack of technical data or a lack of DMEA engineering resources or processes to provide a solution. Furthermore, 11 DoD customers did not pursue a DMEA solution because the customer identified its own solution or the customer did not respond to DMEA followup requests. While the DMEA was able to resolve the majority of customer requests, it is not clear whether the DoD's current use of the ARMS foundry is justified. The DMEA spent $32.4 million between January 1, 2014, and June 30, 2019, to maintain the ARMS foundry while using it to address only 5 DoD customer requests. The DMEA also budgeted $35.8 million to maintain the ARMS foundry from July 1, 2019, through June 30, 2024.

The DMEA Generally Resolved Customer Requests

The DMEA generally resolved customer requests for microelectronics using the ARMS facilities. Specifically, the DMEA identified solutions for 882 of the 908 DoD requests (97 percent) that did not require the use of the ARMS foundry. The DMEA provided various types of solutions to DoD customers, including printed circuit boards, assisting DoD customers in contracting with industry to fill microelectronics needs, locating alternative sources for microelectronics parts, and conducting requested testing. These solutions did not require the use of the ARMS foundry. According to DMEA officials, the DMEA does not compete with commercial companies and when commercial companies can provide a solution, the DMEA will defer to the commercial company. For the 882 DoD requests, the DMEA identified 13 types of alternative solutions. Table 1 shows the DMEA alternative solutions for DoD customers.

Table 1. DMEA Alternative Solutions for DoD Customers

Solution	Definition of Solution Type	Number of DoD Customers
Advanced Technology Support Program (ATSP) Contract	DMEA worked with the DoD customer under the ATSP contract to provide a solution	531
GLOBALFOUNDRIES Contract (began March 31, 2016)	DMEA provided the DoD customer access to the GLOBALFOUNDRIES contract	233
Printed Circuit Boards	DMEA manufactured printed circuit boards that provide electrical connections between chips and electronic components	29
DMEA Identified Source/Solution	DMEA identified a source for the chips and provided the source to the DoD customer	24
Analysis and Test	DMEA confirmed that a component or system met design and manufacturing requirements	18
System Assembly	DMEA assembled a working system to repeatedly perform a specific task	14
Solution in Progress	DMEA identified a solution and is working on implementing it	12
Research/Information	DMEA conducted research or provided information	10
Accreditation	DMEA accredited the DoD customer as a trusted supplier	5
Chip Simulations	DMEA used models to replicate the behavior of a chip	2
Technical Data Package	DMEA provided all the data required to manufacture a product	2
Externally Fabricated Application Specific Integrated Circuit	DMEA designed a chip and provided it to industry for manufacturing	1
Chip Design	DMEA designed a chip for the DoD customer	1
Total		**882**

Source: The DoD OIG.

For example, the DMEA received a request from the U. S. Army Aviation and Missile Research Development and Engineering Center in February 2015 for an interface test adapter circuit card for the Rotorcraft Advanced System Concepts Airborne Lab on the JUH-60A Black Hawk Helicopter. The DMEA used the Packaging and Assembly Substrate Lab to produce the circuit card assembly. The DMEA delivered the circuit card to the customer in October 2015.

In another example, the DMEA received a request from the U.S. Army Natick Soldier Research, Development and Engineering Center to use the ATSP contract. The purpose of the contract action was to design, develop, and prototype a microcontroller for soldier endpoint devices that can control multiple signal requirements in dismounted combat operations. The contract began on July 27, 2016, and a final report was issued on May 29, 2019, that detailed the outputs, schedule, and prototype efforts in support of the soldier endpoint devices project.

In a final example, the DMEA received a request on February 22, 2019, from Warner Robins Air Logistics Complex for help locating an analog switch used on the E-3 Airborne Warning and Control radar. The DMEA was able to locate a supplier who had the parts in stock and informed the customer that the part was available.

Chips and Die for DoD Customers

In addition, between January 1, 2014, and June 30, 2019, the DMEA used the ARMS foundry to fabricate five wafer lots for five DoD customer requests. The DMEA processed these wafer lots into 400 chips and 130 die for DoD customers. Specifically, in the Packaging and Assembly Substrate Lab, the DMEA processed two of the wafer lots into 400 chips for Warner Robins Air Logistics Command employees to replace obsolete chips within the Joint Tactical Information Distribution System, and processed three wafer lots into 130 die to support Air Force Research Lab and Space and Naval Warfare Systems Command (SPAWAR) research efforts.

Between January 1, 2014, and June 30, 2019, the DMEA used the ARMS foundry to fabricate five wafer lots for five DoD customer requests.

The Joint Tactical Information Distribution System is an advanced information distribution system that provides secure integrated communication, navigation, and identification capability for military tactical operations. The DMEA delivered the chips to the Warner Robins Air Logistics Command employees in March 2016. The chips are application-specific integrated circuits that the DMEA custom-designed, manufactured, and tailored for a specific DoD military end use. According to DMEA officials, the Joint Tactical Information Distribution System chips were used in several aircraft platforms, including the E-8 Joint Stars, E-3 Airborne Warning and Control System Sentry, and F-15 Eagle. According to a Warner Robins Air Logistics Command employee, if the DMEA had not manufactured the obsolete chips, he would have needed to find a company outside the Government that could manufacture the chips. However, according to a Warner Robins Air Logistics Command employee, that would have been difficult since some of the data and drawings have limited rights for Government purposes only.

Additionally, the DMEA processed three wafer lots into 130 die to support Air Force Research Lab and SPAWAR research efforts. Specifically, the DMEA processed one wafer lot into 40 die for Air Force Research Lab employees. In February 2014, the DMEA delivered the 40 die as test articles to verify the Air Force Research Lab's inspection techniques, but the 40 die were not incorporated into any weapon system. An Air Force Research Lab employee stated that if the DMEA was unable to provide the required test samples, he would contact other foundries, such as the federally funded Sandia National Laboratory or the federally funded and DoD-sponsored Massachusetts Institute of Technology Lincoln Laboratory, to determine if those labs could provide the test samples.

The DMEA also processed two wafer lots into 90 die for SPAWAR employees to conduct research. In August 2015, the DMEA delivered 60 die to SPAWAR employees to conduct research on the Mid-Infrared Waveguides project, and in April 2018, the DMEA delivered 30 die for the Non-Linearized Integrated Photonics for Waveband Radio Frequencies project. According to a DMEA official, a waveguide is a structure that directs a signal along a defined path to a specific destination. The SPAWAR employees' research goal was to extend the Navy's range of spectrum dominance, which is the ability to defeat any adversary and control any situation within military operations. According to a SPAWAR employee, the waveguides were fabricated for basic research and were not incorporated into any weapon system. Additionally, he explained that if the DMEA did not provide the requested research devices, SPAWAR would need to find another fabrication facility.

The DMEA Did Not Provide Solutions in Some Instances

The DMEA was unable to provide solutions for 10 DoD requests because of a lack of technical data or a lack of DMEA engineering resources or processes to provide a solution. According to DMEA officials, a lack of technical data from the DoD customers prevented the DMEA from providing a solution for eight requests. For example, an Air Force Materiel Command customer requested on November 1, 2016, that the DMEA develop redesign options for an F-16 launcher controller power supply. However, the hardware could not be disassembled to obtain data from the custom chip inside the power supply. Without these data, the DMEA was unable to develop redesign options. According to the Air Force Materiel Command customer, the alternative solution was to purchase a new version of the hardware. For the remaining two requests, DMEA officials stated that they did not have the engineering resources or processes to provide a solution to the DoD customer. For example, an Air Force

The DMEA was unable to provide solutions for 10 DoD requests because of a lack of technical data or a lack of DMEA engineering resources or processes to provide a solution.

Materiel Command customer requested that the DMEA produce a replacement for a radio frequency assembly on April 12, 2017, but the DMEA determined that the scope of the design effort would require more engineering resources than the DMEA had available. According to a DMEA official, the DMEA lacked sufficient engineering staff to take on the project, since all engineers were committed to other projects. The DMEA official explained that the DMEA had been seeking the additional resources to accommodate the increase in demand from DoD programs in prior years, but additional resources had not been provided.

Furthermore, 11 DoD customers did not pursue a DMEA solution because the customer identified its own solution or the customer did not respond to DMEA followup requests. For example, an Air Force Space Command customer requested that the DMEA reverse engineer a pair of logic cards on March 4, 2014, because the original manufacturer was not responding to a request to procure the logic cards. The logic cards perform functions such as thermostat control, door alarms, and control of signals. The original manufacturer eventually contacted the Air Force Space Command and provided the logic cards. Therefore, the Air Force Space Command canceled the request. In another example, a Naval Surface Warfare Center customer requested DMEA assistance on June 1, 2017, with three obsolete field-programmable gate arrays, which are chips designed to be configured by the customer after manufacturing. The field-programmable gate arrays were for the Mark-41 Vertical Launching System installed aboard Navy ships, including the *Ticonderoga* Class Guided Missile Cruisers, *Arleigh Burke*–Class Guided Missile Destroyers, and multiple allied Navy platforms to launch missiles. According to DMEA officials, the Naval Surface Warfare Center was going to inquire about loaning the DMEA the obsolete chips to reverse engineer, but the Naval Surface Warfare Center never inquired.

ARMS Foundry May Not Be Cost Effective

The DMEA spent $32.4 million between January 1, 2014, and June 30, 2019, to maintain the ARMS foundry while using it to address only 5 DoD customer requests.

While the DMEA was able to resolve the majority of customer requests, it is not clear whether the DoD's current use of the ARMS foundry is justified. The DMEA spent $32.4 million between January 1, 2014, and June 30, 2019, to maintain the ARMS foundry while using it to address only 5 DoD customer requests. The DoD customers stated that if the DMEA had not been able to provide these solutions, they would have needed to identify an alternative foundry capable of fabricating a solution.

OUSD(R&E) officials have recently studied the DMEA's initiative to construct a new foundry, including available alternative industry capabilities. In 2010, the DMEA initiated a program to create a new foundry that would be capable of producing smaller wafers than the existing ARMS foundry. According to a DMEA official, smaller, more advanced semiconductor technologies can improve chip performance. In 2017, the DMEA started the 3-year construction phase of the new foundry. In March 2019, the DMEA provided a status update to the OUSD(R&E) on the new foundry. This update revealed a design change resulting in a 3-year schedule delay. Additionally, the DMEA identified a cost increase of $193 million over the original estimate of $174 million and a requirement for additional staffing. OUSD(R&E) officials requested independent reviews from industry, Government, and experts in academia on the plan to construct the new foundry. The independent reviews found that alternative sources of the new foundry capabilities already existed at a lower cost. Additionally, OUSD(R&E) officials found that the original projected capabilities of the new foundry was significantly greater than the projected demand for those capabilities. As a result of the study, OUSD(R&E) officials stopped construction of the new foundry as of May 24, 2019.

The DMEA also budgeted $35.8 million to maintain the ARMS foundry from July 1, 2019, through June 30, 2024. The cost to maintain the ARMS foundry included direct labor, subcontracted services, supplies and maintenance materials, chemicals, gases, and wafers. According to DMEA and OUSD(R&E) officials, no study or business case analysis on the costs and benefits of the existing ARMS foundry has been conducted, even though the existing ARMS foundry has only been used to provide 5 customer solutions in the last 5 ½ years. Since the review of the new foundry identified that alternative sources of the new foundry capabilities already existed at a lower cost, a study of the existing ARMS foundry could identify similar findings. Therefore, OUSD(R&E) officials should complete an assessment of the use of the existing foundry and determine whether the existing foundry is still needed.

Management Comments on the Finding and Our Response

The Acting Director of Defense Research and Engineering for Research and Technology, OUSD(R&E), commented on the report and stated that the availability of viable, on-shore sources for DoD microelectronics is meager and at a continuously increasing risk. Therefore, she stated that the report's assertion that if the DMEA were unable to develop and produce the provided solution, customers would merely need to find alternative manufacturing sources,

is incomplete when considering the microelectronics fabrication landscape. The Acting Director stated that many customers rely on DMEA expertise and experience in defining their requirements from a microelectronics perspective prior to identifying possible solutions, whether or not those solutions include the use of internal DMEA capabilities.

Our Response

We included specific responses from DoD customers within the report. DoD customers stated that they would have needed to identify an alternative foundry capable of fabricating a solution if the DMEA had not been able to provide these solutions.

Recommendations, Management Comments, and Our Response

Recommendation 1

We recommend that the Director of Defense Research and Engineering for Research and Technology, Office of the Under Secretary of Defense for Research and Engineering, complete an assessment of the use of the existing foundry and determine whether the existing foundry is still needed.

Office of the Under Secretary of Defense for Research and Engineering Comments

The Acting Director of Defense Research and Engineering for Research and Technology, OUSD(R&E), agreed with the recommendation and stated that she will conduct the assessment.

Our Response

Comments from the Acting Director of Defense Research and Engineering for Research and Technology, OUSD(R&E), addressed the specifics of the recommendation because the Acting Director will conduct the recommended assessment; therefore, the recommendation is resolved but will remain open. We will close the recommendation once the OUSD(R&E) provides documentation to verify that an assessment of the use of the existing foundry was completed and a determination was made regarding whether the existing foundry is still needed.

Appendix

Scope and Methodology

We conducted this performance audit from July 2019 through February 2020 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

To determine whether the DMEA resolved customer requests for microelectronics using the ARMS facilities, we contacted officials from the following organizations to identify the roles and responsibilities related to the DMEA and obtain customer request and solution documentation from January 1, 2014, to June 30, 2019:

- OUSD(R&E);
- Assistant Secretary of the Army (Acquisition, Logistics and Technology);
- Assistant Secretary of the Navy for Research, Development and Acquisition;
- Assistant Secretary of the Air Force (Acquisition, Technology and Logistics);
- DMEA; and
- 18 DoD program managers.

DMEA officials provided a listing of 1,592 customer requests received from January 1, 2014, to June 30, 2019. DMEA officials manually consolidated the 1,592 customer requests from the DMEA Customer Request System, Microelectronics Project System, and databases maintained by DMEA officials outside of a system related to ATSP workload, GLOBALFOUNDRIES contract requests, radiation lab test logs, and accreditation reviews. See Table 2 for the DMEA customer requests categorized by type of request.

Table 2. Customer Requests Received by the DMEA by Type of Request

Type of Request	Total Number of Requests
Microelectronics	661
GLOBALFOUNDRIES Contract	436
Analysis and Test	258
Accreditation	200
Research and Information	37
Total	**1,592**

Source: The DoD OIG.

We obtained the DMEA documentation related to the mission, capabilities, and processes for receiving customer requests and providing solutions. Additionally, DMEA officials provided listings of solutions for the 1,592 requests, including chips designed and fabricated by the DMEA or the Defense industry, chip simulation, printed circuit boards, system assembly, technical data packages, use of the ATSP and GLOBALFOUNDRIES contracts, analysis and test, accreditation, and research and information. Additionally, the listing of solutions identified instances where the DMEA identified another source for the solution, the solution was still in progress, or the customer did not pursue the DMEA solution.

Of the 1,592 requests, the Military Services and other DoD agencies requested DMEA assistance with 908 solutions for microelectronics, access to the GLOBALFOUNDRIES contract, analysis and test, and research and information. We focused our review on the DoD customers because they had the most requests related to microelectronics, which may require the use of the ARMS foundry. The non-DoD customers primarily requested access to the GLOBALFOUNDRIES contract, analysis and test, or accreditation to become a trusted source. Although we did not focus on the non-DoD customers, we identified that the DMEA did not produce any solutions for the non-DoD customers using the ARMS foundry between January 1, 2014, and June 30, 2019. We selected a nonstatistical sample of 29 DMEA solutions provided to DoD customers and either contacted the DoD customer or obtained documentation, including chip design specification packages, signed customer delivery forms, and test reports to validate the solution the DMEA provided. We validated that the information provided by the DMEA was accurate for the purposes of the audit. See Table 3 for details on the nonstatistical sample of the DMEA solutions reviewed to validate the level of support DMEA provided.

Table 3. Sample of DMEA Solutions Reviewed to Validate DMEA Level of Support

Solution Category	Number of Solutions Validated With Customer Outreach or Documentation
Analysis and Test	5
DMEA Fabricated Wafers	5
DMEA Identified Source/Solution	4
ATSP Contract	4
DMEA Could Not Provide Solutions	2
Chip Simulations	2
Technical Data Package	2
Customer Did Not Pursue DMEA Solution	1
Printed Circuit Boards	1
Solution in Progress	1
Externally Fabricated Application Specific Integrated Circuit	1
Chip Design	1
Total	**29**

Source: The DoD OIG.

Additionally, we distributed a survey to Army and Air Force acquisition personnel asking if they had contacted the DMEA in the past 5 ½ years to verify the completeness of the DMEA-provided customer request universe. We validated that the information provided by the DMEA was complete for the purposes of the audit. The Navy could not provide an appropriate point of contact in a timely manner so we did not distribute the survey to Navy personnel. We also obtained documentation from OUSD(R&E) officials related to the new ARMS foundry, plans for DoD microelectronics, and the DMEA budget.

Use of Computer-Processed Data

We used computer-processed data from Customer Request System and Microelectronics Project System. Both are DMEA-developed systems that maintain customer requests and DMEA projects that provided solutions to those customer requests. Specifically, the Customer Request System is a web-based system that tracks a request through the assessment of the project and is intended to capture information about customer interactions from the time the customer contacts the DMEA until a solution is provided to the customer. The Microelectronics Project System is also a web-based system that includes details for each DMEA

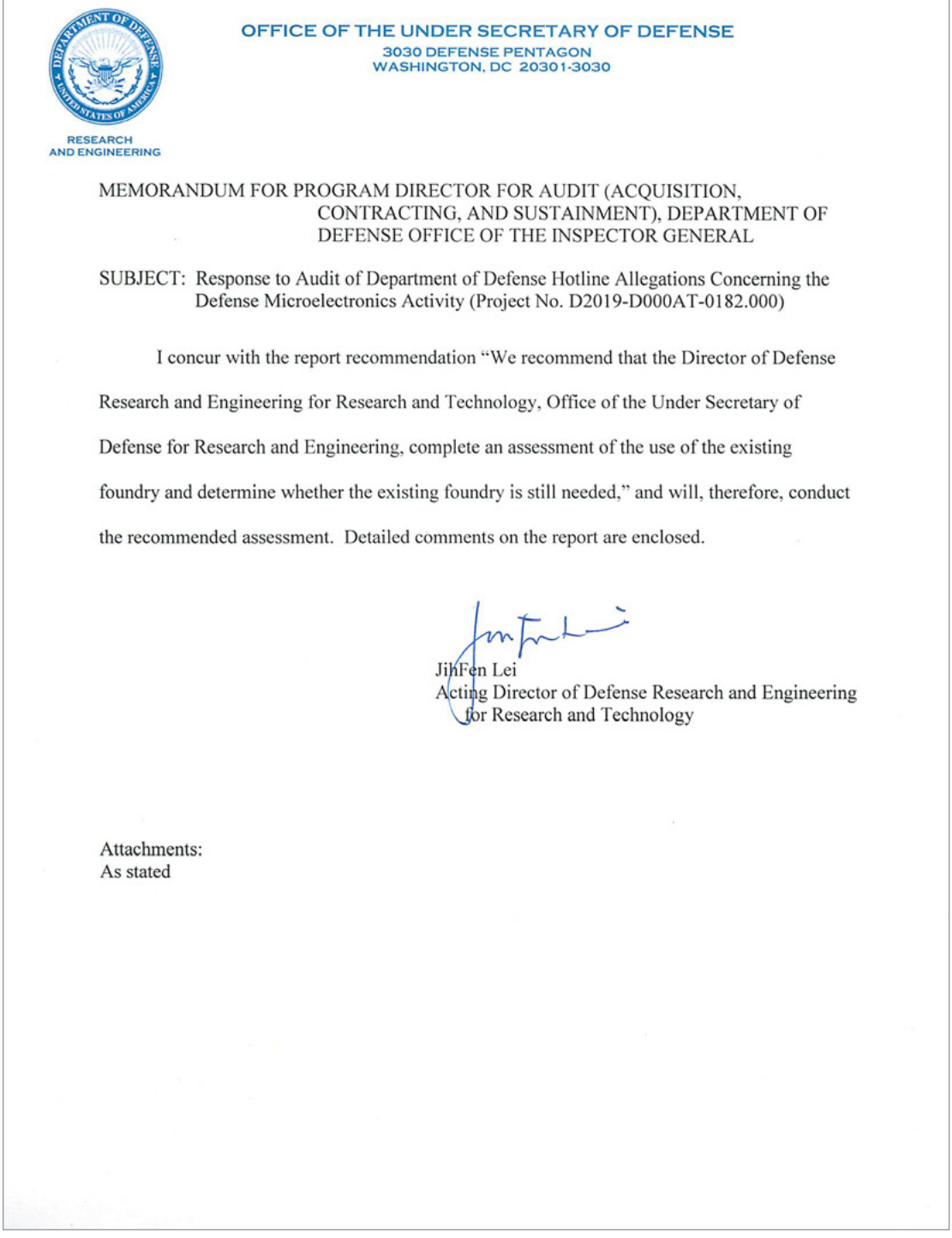
project, including the title, assigned DMEA personnel, status, and type of request. To validate information contained within the systems, we selected a nonstatistical sample of DMEA solutions and obtained documentation to support the solution, including chip design specification packages, signed customer delivery forms, and test reports. We also contacted a nonstatistical sample of DoD customers to verify the level of support provided by the DMEA. We determined that the data were sufficiently reliable for the purposes of this report.

Prior Coverage

No prior coverage has been conducted during the last 5 years related to the DMEA's use of the ARMS facility to manufacture replacement chips.

Management Comments

Office of the Under Secretary of Defense for Research and Engineering



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RESEARCH
AND ENGINEERING

MEMORANDUM FOR PROGRAM DIRECTOR FOR AUDIT (ACQUISITION, CONTRACTING, AND SUSTAINMENT), DEPARTMENT OF DEFENSE OFFICE OF THE INSPECTOR GENERAL

SUBJECT: Response to Audit of Department of Defense Hotline Allegations Concerning the Defense Microelectronics Activity (Project No. D2019-D000AT-0182.000)

I concur with the report recommendation "We recommend that the Director of Defense Research and Engineering for Research and Technology, Office of the Under Secretary of Defense for Research and Engineering, complete an assessment of the use of the existing foundry and determine whether the existing foundry is still needed," and will, therefore, conduct the recommended assessment. Detailed comments on the report are enclosed.

JihFen Lei
Acting Director of Defense Research and Engineering
for Research and Technology

Attachments:
As stated

Office of the Under Secretary of Defense for Research and Engineering (cont'd)

DoD IG Draft Report for Project No. D2019-D000AT-0182.000

"Audit of DoD Hotline Allegations Concerning the Defense Microelectronics Activity"

Department of Defense Comments on the DoD IG Report and Recommendations

RECOMMENDATION 1: "We recommend that the Director of Defense Research and Engineering for Research and Technology, Office of the Under Secretary of Defense for Research and Engineering, complete an assessment of the use of the existing foundry and determine whether the existing foundry is still needed."

COMMENTS ON RECOMMENDATION 1: The Acting Director of Defense Research and Engineering for Research and Technology accepts the recommendation, and will, therefore, conduct the recommended assessment. The Defense Microelectronics Activity (DMEA) has already initiated an evolution of the business model for the Advanced Reconfigurable Manufacturing for Semiconductors (ARMS) foundry to include a pure-play model (i.e., the offering of robust process development kits allowing external customers to use the DMEA fabrication facility for their own designs, rather than a design and build methodology) to supplement the end-to-end capabilities currently provided, as well as Science, Technology, Engineering, and Math (STEM) educational opportunities for universities.

COMMENTS ON REPORT: While the report briefly mentions potential issues faced by DoD programs for the manufacture of microelectronics (i.e., intellectual property issues), it should be further noted that, as identified in multiple previous reports on the subject (e.g., GAO-18-43SU, GAO-16-185T, GAO-05-278, and DSB study "High Performance Microchip Supply, and others), the availability of viable, on-shore sources for DoD microelectronics is meager and at continuously increasing risk (especially considering the DoD-specific performance, extreme low volume, and security requirements). The statements that, if DMEA were unable to develop and produce the provided solution, customers would merely need to find alternative manufacturing sources are, therefore, incomplete when considering the microelectronics fabrication landscape. Indeed, many customers rely on DMEA expertise and experience in defining their requirements from a microelectronics perspective prior identifying possible solutions, whether or not those solutions include the use of internal DMEA capabilities.

The Under Secretary of Defense for Research and Engineering (USD [R&E]) Microelectronics Team, including DMEA, is working together to address the issues raised in this report.

Acronyms and Abbreviations

ARMS	Advanced Reconfigurable Manufacturing for Semiconductors
ATSP	Advanced Technology Support Program
DMEA	Defense Microelectronics Activity
OUSD(R&E)	Office of the Under Secretary of Defense for Research and Engineering
SPAWAR	Space and Naval Warfare Systems Command


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