LEWIS–BURKE ASSOCIATES LLC

Federal Microelectronics Overview – February 2021

Lewis-Burke Associates LLC – February 12, 2021

Microelectronics research and manufacturing is a growing priority across federal agencies, Congress, and the Administration. Federal agency budget requests for fiscal year (FY) 2021 highlighted the importance of next-generation microelectronics research across agencies and we expect this to ramp up in FY 2022.

In August 2020, the Trump Administration released the annual guidance to federal agency leadership on "Fiscal Year (FY) 2022 Administration Research and Development Budget Priorities and Cross-cutting Actions.[1]" Microelectronics was included under the heading of National Security, specifically: "Departments and agencies, working together and in collaboration with industry and academic partners where appropriate, should prioritize investments to ensure government access to trusted and assured microelectronics and continued American leadership in semiconductor technologies, including the underlying materials, devices, designs, and software; and the fabrication and characterization tools and facilities required for advanced microelectronics."

President Biden is expected to continue the Trump Administration's focus on industries of the future, including next generation microelectronics, but with increased focus on basic research and development (R&D). U.S. leadership in emerging technologies, such as microelectronics continues to be key to national security.

Finally, in December 2020, the *Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America Act* was signed into law. The CHIPS Act authorizes expanded and/or new research and development efforts at the Department of Defense (DOD), the Department of Energy (DOE), and the National Science Foundation (NSF) to ensure U.S. leadership in semiconductor technology and innovation.

Additional information on congressional and federal agency interest and activity related to microelectronics is presented below.

Congressional Overview: Authorizations and Fiscal Year (FY) 2021 Appropriations

FY 2021 National Defense Authorization Act (NDAA)

In December 2020, Congress passed the annual defense policy bill for FY 2021, the National Defense Authorization Act (NDAA). While the NDAA authorizes funding levels and sets policy and program priorities for DOD, funding is directed through the defense appropriations bill. The FY 2021 NDAA includes many congressional priorities for addressing national security challenges from Chinese threats to the U.S. research and innovation enterprise science and technology investments, including industries of the future and emerging—artificial intelligence, cybersecurity, **microelectronics**, 5G, quantum, hypersonics, directed energy, and biotechnology.

[1] https://www.whitehouse.gov/wp-content/uploads/2020/08/M-20-29.pdf

In Section 276 of the NDAA titled "Microelectronics and National Security," Congress urges the continuing production of cutting-edge "microelectronics for national security needs, including access to state-of-of the-art node sizes thorugh commercial manufacturing, heterogenous integration, advantaged sensor manufacturing, boutique chip designs, and variable volume production capabilities."

Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America Act

As part of the FY 2021 NDAA, Congress passed the *Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America Act* to authorize a $15 billion initiative to establish a cutting-edge, domestic microelectronics industry. Most of the authorized funding is directed at expanded or new research and development efforts at DOD, NSF, and DOE to ensure U.S. leadership in semiconductor technology and innovation. The CHIPS Act is largely driven by competitiveness with China and addressing the technology roadmap "Made in China 2025."

Key provisions in CHIPS include:

- Form a subcommittee under the National Science and Technology Council focused on microelectronics, which would be tasked with developing a National Strategy on Microelectronics Research;
- Require DOD to assess the need of establishing a national laboratory with a commercial incubator "exclusively focused on the research and development of microelectronics to serve as a center for Federal Government expertise in high-performing, trusted microelectronics and as a hub for Federal Government research into breakthrough micro-electronics technologies;"
- Establish a new manufacturing institute focused on microelectronics; and
- Establish an Industrial Advisory Committee with representatives from industry, academia, and federal laboratories.

The provisions authorized in the CHIPS Act will now need to be funded through the congressional FY 2022 appropriations process.

FY 2021 Appropriations Language for the Department of Defense (DOD):

- The FY 2021 appropriations bill for DOD provides funding increases for several technology priorities, such as artificial intelligence, quantum information science, hypersonics, **microelectronics**/fifth generation wireless (5G), and space technology.
- The bill includes an additional $15 million in funding for trusted and assured microelectronics.

STATE OF PLAY ACROSS FEDERAL AGENCIES

DEPARTMENT OF DEFENSE (DOD)

The DOD budget request for FY 2021 included $1.5 billion to continue addressing trusted and assured supply of microelectronics; hasten adoption of "ubiquitous connectivity" and sharing more data at greater network bandwidth. Mark Lewis, the former Acting Deputy Undersecretary of Defense for Research and Engineering and Director of Defense Research and Engineering for Modernization has stated that microelectronics is the Pentagon's top priority, and that "We want to move away from trusted foundries and instead move towards technologies that allow us to operate and develop trusted

components in zero-trust environments.[2]" Within DOD Nicole Petta, Assistant Director for Microelectronics, is working on a roadmap to meet this goal by 2023.

DOD programs of interest are described below.

DARPA – DARPA is focused on starting the next phase of the Electronics Resurgence Initiative (ERI), an effort that started in 2017 to shore up the microelectronics sector. DARPA plans to issue an RFI early in 2021 to gather ideas on how to move forward.

In July 2019, DARPA announced the new MTO effort called the Microsystems Exploration program. The Microsystems Exploration program will constitute a series of short-term investments into high-risk, high-reward research focused on technical domains relevant to MTO. Leveraging streamlined contracting and funding approaches, awards for each area of exploration – or µE topic – will be made within 90 days of announcement. Each µE topic will run for up to 18 months, during which time researchers will work to establish the feasibility of new concepts or technologies.

Service Laboratories:

- Air Force Office of Scientific Research (AFOSR):
  - Key programs are in include in the AFOSR Broad Agency Announcement (BAA) available at https://www.grants.gov/web/grants/view-opportunity.html?oppId=314753.
  - Mechanics of Multifunctional Materials and Microsystems (page 46 and here)
  - Optoelectronics and Photonics (page 35 and here)
  - Electromagnetics (page 33 and here)
- Office of Naval Research (ONR):
  - Electronic Devices, RF Semiconductors and Amplifiers; available here.
  - Nanoscale Computing Devices and Systems; available here.
- ARO:
  - Computational Architectures; available in the BAA on page 34.

Multidisciplinary University Research Initiatives (MURI) Program – While not an award for a large center, DOD's MURI program provides $1.25 to $1.5 million over a three-year award period to research topics of interest to the Services. Research topics vary by year and are submitted by the Services' research offices. The last several years have seen microelectronics topics DOD leadership has indicated that this will continue.

NATIONAL SCIENCE FOUNDATION (NSF)

The Engineering Directorate (ENG) leads on NSF basic research related to Semiconductors and Microelectronics, with the Division of Materials Research (DMR) also funding a number of related projects. In the President's budget request for FY 2021, NSF included $84 million to support fundamental research on the concepts, materials, devices, circuits, and platforms needed to advance semiconductor and microelectronic technologies. The request states that outcomes of this research will benefit microelectronics design, architecture, and fabrication, as well as high-performance computing and the broader Industries of the Future.

[2] https://www.govconwire.com/2020/12/dods-dr-mark-lewis-to-discuss-development-of-innovative-technologies-during-potomac-officers-clubs-7th-annual-defense-randd-summit/

DEPARTMENT OF ENERGY (DOE)

Microelectronics research and development is an emerging priority for DOE. In FY 2020 and FY 2021, DOE has allocated about $5 million for microelectronics research and development, but that is expected to grow to $45 million in FY 2022 and more than $100 million in the next few years. DOE has identified next generation microelectronics as necessary to make advances for future computing, sensors, and detectors to support DOE missions in energy, the environment, and national security. Similar to quantum and Artificial Intelligence, DOE has established a multi-disciplinary program to address research needs. Led by Basic Energy Sciences, but in partnership with Advanced Scientific Computing Research (ASCR), High Energy Physics (HEP), and Fusion Energy Sciences (FES), the goal is to support multi-disciplinary microelectronics research to accelerate the advancement of microelectronic technologies in a co-design innovation ecosystem in which materials, chemistries, devices, systems, architectures, algorithms, and software are developed in a closely integrated fashion. DOE is planning to launch microelectronics research centers in addition to funding core research.

Energy Frontier Research Centers (EFRCs) – DOE currently funds two EFRCs focused on microelectronics first awarded in 2020. DOE has not yet announced the topic areas for the next EFRC competition expected in November 2021, but microelectronics will likely be a topic area again. The 2021 competition is to recompete and award up to 42 centers. DOE usually funds up to 15 new EFRCs while the rest tend to be renewals. The awards will range from $2 million to $4 million per year for each center over four years.

Report on Basic Research Needs for Microelectronics – This report is the result of a workshop held in October 2018 to identify priority research directions (PRDs) in microelectronics for the DOE Office of Science (SC). We recommend faculty review the PRDs to identify areas of overlap between research goals and the PRDs. The contents of this report will shape SC's nascent crosscutting initiative in microelectronics and the associated funding opportunities. Knowledge of the PRDs will also help faculty make a more compelling pitch to program officers when reaching out regarding potential research funding. The five priority research directions include:

1. Flip the current paradigm: Define innovative material, device, and architecture requirements driven by applications, algorithms, and software;
2. Revolutionize memory and data storage;
3. Reimagine information flow unconstrained by interconnects;
4. Redefine computing by leveraging unexploited physical phenomena; and
5. Reinvent the electricity grid through new materials, devices, and architectures.

The full report is available at: https://science.osti.gov/-/media/bes/pdf/reports/2019/BRN_Microelectronics_rpt.pdf.

BES Programs – Descriptions of the BES programs are below, with language relevant to microelectronics highlighted.

- Experimental Condensed Matter Physics
- Physical Behavior of Materials

Additional information can be found in the annual SC broad announcement: https://science.osti.gov/-/media/grants/pdf/foas/2021/DE-FOA-0002414.pdf.

Future Microelectronics Solicitations – In FY 2022, DOE plans to request $45 million to launch microelectronics research centers and continue to fund single-PI core research. About $10 million would support single Principal Investigator and small group awards focused on materials, chemistry, and

fundamental device science. The remaining $35 million would be for multi-disciplinary, co-design centers, in partnership with Advanced Scientific Computing Research (ASCR), High Energy Physics (HEP), and Fusion Energy Sciences (FES) within the Office of Science. Key technical areas will include materials, chemistry, and fundamental device science; component integration, architecture, and algorithms; and next-generation tools for synthesis, fabrication, and characterization of devices and systems. DOE is aware that computing systems encompassing new materials, devices, architectures, algorithms, and software are needed to maintain the continued upward trajectory in performance that Moore's law scaling has historically provided. Optimization must occur at every level of computing and power microelectronics systems. Among the challenges is discovery science that can lead to microelectronics for exascale computers and beyond with a small footprint and low power utilization. Such high-performance computation will be necessary for analyzing and managing the vast amount of data that will be generated by future Office of Science facilities to enable new discoveries. Furthermore, transforming power electronics and the electricity grid into a modern, agile, resilient, and energy-efficient system requires advances in new microelectronics materials, and their integration within a co-design framework. The microelectronics research centers are intended to address this broad range of issues.