

# Advancing Performance in 3DHI

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## ABSTRACT

While silicon transistor scaling is certain to continue over the next decade, traditional technology scaling alone will provide diminishing cost and performance improvements over time and is unlikely to drive future long-term microelectronics innovation. Access to leading-edge silicon microelectronics, while critical, must be regarded as just one element of a longer-term view of advanced capabilities and supply chain security. This longer view must address the next wave of innovation that will overtake the role in economic growth that, until now, has been held by complementary metal oxide semiconductor transistor scaling. The next major wave of microelectronics innovation is expected to come from the ability to integrate heterogeneous materials, devices, and circuits through advanced packaging, producing a tightly-coupled system that extends into the third dimension with performance that exceeds what is available from today's monolithic approach. This approach is widely known as three-dimensional heterogeneous integration, or 3DHI.

To address known barriers to 3DHI research and development access and cycle time, the Defense Advanced Research Projects Agency (DARPA) launched Next-Generation Microelectronics Manufacturing (NGMM), an \$840M, six-year program executed in three phases. Phase 0, now complete, informed planning for the 3DHI manufacturing center by defining exemplar 3DHI microsystems and identifying the equipment, process, and facility requirements for manufacturing these microsystems. Phase 1, expected to kick off in summer 2024, will focus on procuring and installing equipment, establishing baseline fabrication processes, developing a 3D assembly design kit (3D-ADK), and design automation and simulation software tailored to 3DHI. Phase 2 will build on Phase 1 to create hardware prototypes, automate processes, and develop emulation capabilities. The end goal of the program is to establish a self-sustaining 3DHI manufacturing center at an existing facility that is owned and operated by a non-federal entity, and accessible to users in academia, government, and industry. Success will be measured by the ability to support the design, fabrication, assembly, and test of a wide range of high-performance 3DHI microsystems at reasonable cost with cycle times supporting fast-paced innovative research. This talk will provide an overview of the national-level initiatives in microelectronics, give an update on the NGMM program, and show some 3DHI performance improvement results from ongoing DARPA research programs relevant to microwave theory and technologies.

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