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# Nanoelectronics Research for Computing beyond CMOS

As a leading research consortium in the semiconductor industry, the Semiconductor Research Corporation (SRC) has funded academic research for over 35 years, helped to invent some of the most important semiconductor technologies, and educated generations of experts and technology leaders for the industry. Through a collaborative research platform provided by SRC, major semiconductor companies partner with US government funding agencies (e.g., DARPA, NSF, NIST) to sponsor cutting-edge research at the universities to advance semiconductor technologies. The "Nanoelectronics Research Initiative (NRI)" was co-funded by SRC, NSF, and NIST in 2005 with an ambitious goal – to explore nanoelectronic switches fundamentally different from CMOS transistors to achieve orders of magnitude lower switching energy. NRI has made significant contributions to the fundamental research of novel materials and devices; however, no new switch has been identified to be capable of replacing CMOS. Important lessons learned from the NRI program have helped to define the strategies of new nanoelectronics research programs: (1) unique characteristics of nanoelectronic materials and devices may be utilized for novel computing paradigms beyond Boolean logic and von Neumann architectures; (2) basic material and device research play critical roles to enable novel computing solutions; (3) beyond-CMOS research requires a holistic approach with device-architecture cooptimization supported by innovations in characterization, fabrication, and modeling. A joint NSF-SRC program, "Energy-Efficient Computing from Devices to Architectures (E2CDA)", was launched in 2017 to address the cooptimization of emerging devices and architectures to achieve over 100x improvement in system-level energy efficiency. Based on the learning from NRI, a follow-on "nanoelectronic Computing Research (nCORE)" program was launched in 2018 by SRC, NIST, and NSF to explore emerging material, device, and interconnect solutions to enable novel computing and storage paradigms based on a holistic approach. The nCORE program has funded research in 2D materials, spintronic materials and devices, analog/neuromorphic computing devices, new interconnect materials, as well as novel computing architectures including in-memory computing, probabilistic computing, etc. This talk will present these nanoelectronics research programs at SRC, review the lessons learned, and discuss potential future directions.