

# The Semiconductor Industry's Nanoelectronics Research Initiative: Motivation and Challenges

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In recent generations of CMOS technology, exponentially increasing power density due to leakage currents as well as active switching energy of these nanoscale transistors is limiting our ability to reap the historical benefits of continued scaling. As the ultimate limits to CMOS scaling are getting closer, completely new approaches in emerging areas in electronics at the nanoscale need to be explored. Recognizing this critical challenge, the Nanoelectronics Research Initiative (NRI) was chartered in 2005 by a consortium of Semiconductor Industry Association (SIA) member companies to develop and administer a university-based program to address this issue.

NRI Mission: Demonstrate novel computing devices capable of replacing the CMOS FET as a logic switch in the 2020 timeframe.

- These devices should show significant advantage over ultimate FETs in power, performance, density, and/or cost to enable the semiconductor industry to extend the historical cost and performance trends for information technology.
- To meet these goals, NRI is focused primarily on research on devices utilizing new computational state variables beyond electronic charge. In addition, NRI is interested in new interconnect technologies and novel circuits and architectures, including non-equilibrium systems, for exploiting these devices, as well as improved nanoscale thermal management and novel materials and fabrication methods for these structures and circuits.
- Finally, it is desirable that these technologies be capable of integrating with CMOS, to allow exploitation of their potentially complementary functionality in heterogeneous systems and to enable a smooth transition to a new scaling path.

In this talk, the scaling challenges facing current CMOS technology will be discussed, along with the ultimate limits for charge-switching based devices. From this motivation, the current status of the NRI program will be discussed, with an overview of the current research topics being investigated at the NRI centers.