Emerging Research Devices

--- International technology roadmap for semiconductors
Challenges in the Microelectronics Industry

- Challenges related to logic
  - To extend the CMOS technology to and beyond 45 nm nodes
  - Invention and reduction to practice of a new manufacturable information and signal processing technology addressing beyond CMOS applications

- Challenges related to memory technologies
  - Need a new memory technology to combine the best features of volatile and non-volatile memories
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- New Devices
  - Non-classical CMOS
  - Memory devices
  - Logic Devices

- New Architecture
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----Non-classical CMOS

- Advanced MOSFETs
  - Provide a path to scaling CMOS to the end of Roadmap using new transistor structural designs and new materials

- Definitions and classifications
  - Transport-enhanced FETS: enhance the velocity of the carriers
  - Ultra-thin Body SOI FETs: a thin transistor body is employed
  - Source/Drain Engineered FETs: engineering the source/drain
  - Multiple Gate FETs:
    - N-Gate (N>2) FETs: use more than two gates to improve electrostatic control
    - Double-gate FETs: use two isolated gates for low-power and mixed-signal processing
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----Memory devices

- Attempt to mimic and improve on the capabilities of present day memory technologies

- Definitions and classifications
  - Phase change memory
  - Floating body DRAM
  - Nanofloating gate memory (NFGM)
  - Single/few electron memory
  - Insulator resistance change memory
  - Molecular memory
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----Logic Devices

- New technologies based on something other than electronic charge that... extend the scaling of information processing technologies through multiple generations beyond 2019.

- Fundamental requirements
  1. be able to extend microelectronic orders of magnitude beyond the domain of CMOS and be capable of integration on or with a CMOS platform;
  2. be able to provide a means for an energy restorative functional process to sustain steady operation
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Logic Devices

- Resonant tunnel devices
- Single-electron transistors
- Rapid single flux quantum (RSFQ)
- Quantum cellular automata (QCA)
- 1D structures
- Molecular devices
- Spin transistors
Emerging Research Architectures

- Fine-Grained parallel implementations in nano-scale cellular arrays
  - Quantum cellular automata architecture implementations
  - Cellular nonlinear networks
- Defect tolerant architecture implementations
- Biologically inspired architecture implementations
- Coherent quantum computing
Functional Comparison

- In the comparisons of newly emerging technologies:
  - Few of the new technologies are directly competitive with scaled CMOS
  - Most are highly complimentary
  - Heterogeneous integration of the emerging technologies with silicon can expand its overall application space.