



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

DOE “Big Idea” concept proposed by DOE Labs

March 06, 2017

NICE Workshop at IBM Research-Almaden

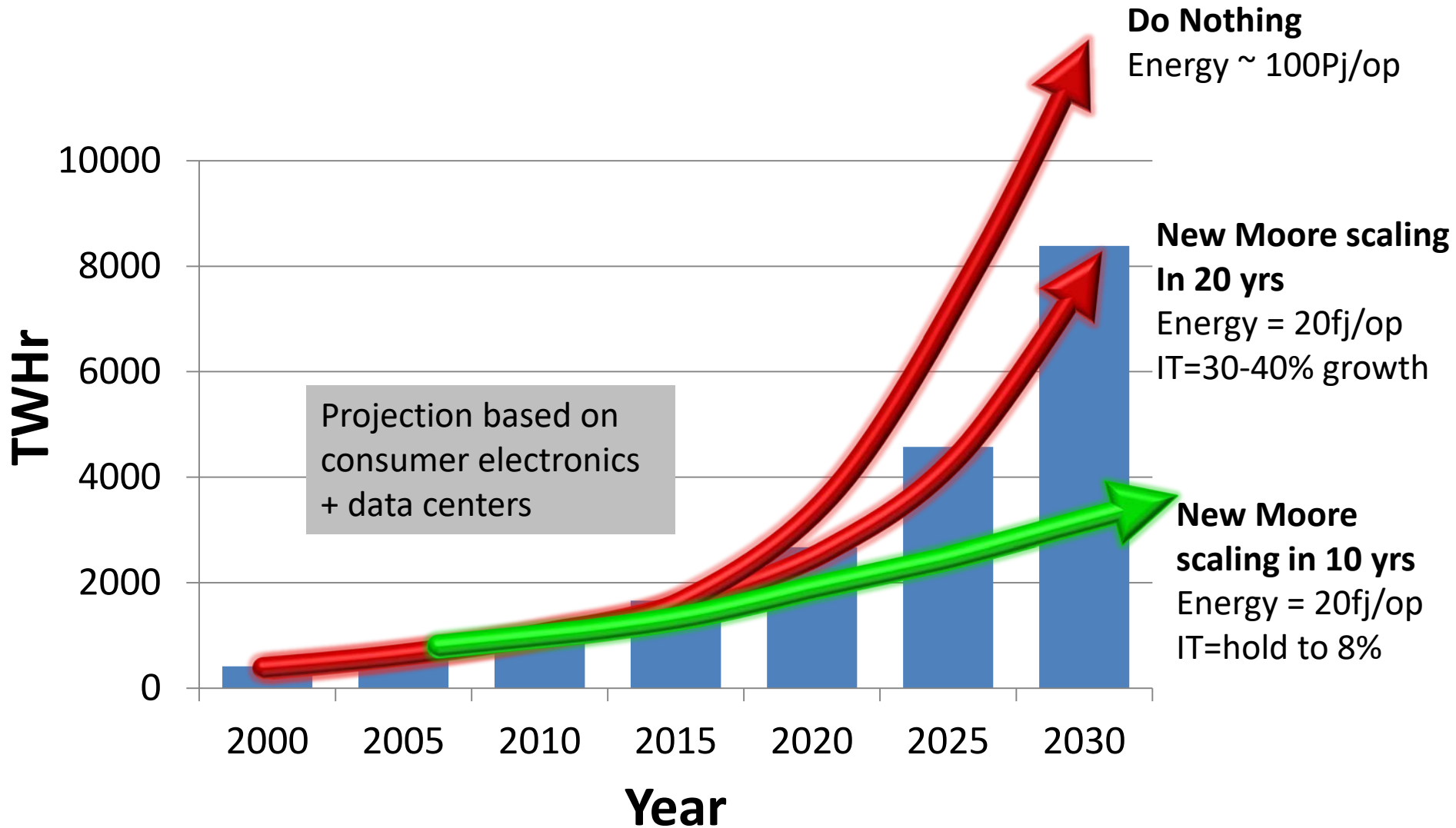
Dev Shenoy

Chief Engineer

Advanced Manufacturing Office

www.manufacturing.energy.gov

IT challenge for future electricity supply



Beyond Moore Co-design Framework

10,000x improvement: 20 fJ per instruction equivalent

Modeling

Experimental

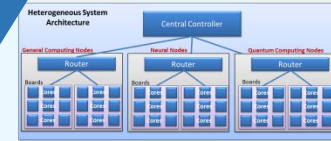
Algorithms and Software Environments

- Application Performance Modeling



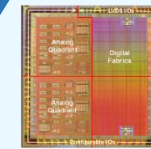
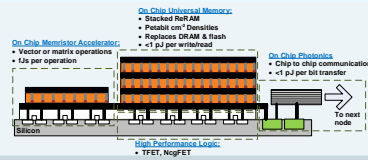
Computer System Architecture Modeling

- Next generation of Structural Simulation Toolkit
- Heterogeneous systems HPC models



Microarchitecture Models

- McPAT, CACTI, NVSIM, gem5

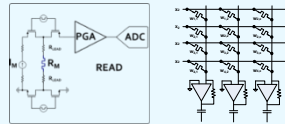


Component Fabrication

- Processors, ASICs
- Photonics
- Memory

Circuit/IP Block Design and Modeling

- SPICE/Xyce model

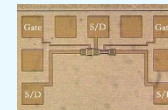
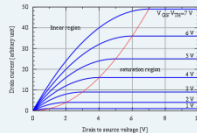


Test Circuit Fab and Measurement

- Subcircuit measurement

Compact Device Models

- Single device electrical models
- Variability and corner models

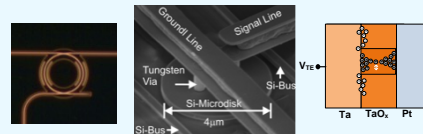


Device Measurements

- Single device electrical behavior
- Parametric variability

Device Physics Modeling

- Device physics modeling (TCAD)
- Electron transport, ion transport
- Magnetic properties

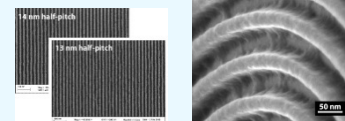
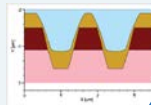


Device Structure Integration and Demonstration

- Novel device structure demonstration

Process Module Modeling

- Diffusion, etch, implant
- Simulation
- EUV and novel lithography models

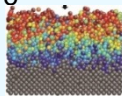


Process Module Demonstrations

- EUV and novel lithography
- Diffusion, etch, implant simulation

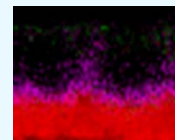
Atomistic and Ab-Initio Modeling

- DFT – VASP, Socorro
- MD – LAMMPS



Fundamental Materials Science

- Understanding Properties/Defects via Electron, Photon, & Scanning Probes
- Novel Materials Synthesis



Example activities within a MCF

Advanced Manufacturing

Materials

Devices

Architectures

Algorithms

Algorithms & SW Environments

Hardware & Circuit Architectures

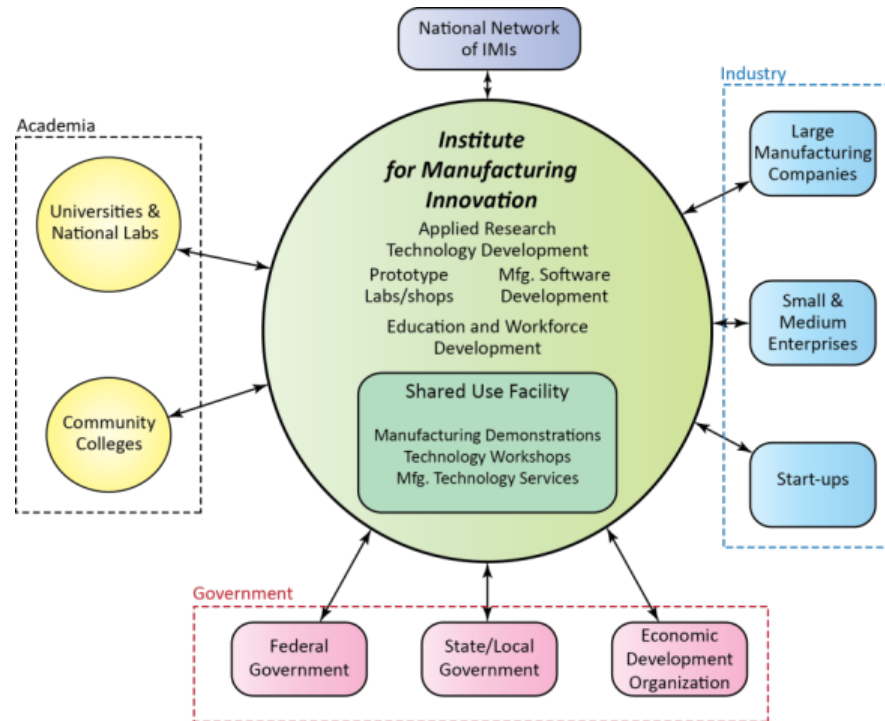
Comm., Memory & Computation Devices

Materials

Industry-Academia-Government Partnership

Microelectronics:

- 1) Beyond von-Neumann architectures
- 2) Clear industry value proposition
- 3) Strong Partnerships
- 4) Ability to address critical challenges
- 5) A balanced portfolio of projects



Open Consortium—new members able to join