Workshop on the Frontiers of Extreme Computing
Overall Outbrief

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- **Support IBM's call for research in RL TS – caveat requires 3 orders of magnitude reduction in clock**
- **Search for more real world problems suitable for solution on a QC RL surprised by length of list**
- **Demonstrate ways of using nano technologies (by researching architectures-- including quirks and features) for solving important problems**
- **Gao's implementation idea**

- **Applications up to the Zettaflops level have been seriously proposed.**
  - **Climate modeling: Expected to reach 1 Zettaflops.**
  - **Plasma fusion simulation: Proposed increase xx, with expectation that this will come from hw and algorithms**
  - **NASA: Simulation algorithms to Zettaflops and above, limited by computers**
  - **Cryptanalytic algorithms were not discussed, but are understood to be well above Zettaflops NSA neither confirms nor denies this statement**

- **Technologies for faster computers exist to very high performance levels in a series of tiers:**
  - **First tier: Continued evolution of transistors, nanotech, superconducting devices**
    - **Defined as logic operation below thermodynamic limit**
  - **Second tier**
    - **QDCA, superconducting option**
    - **Defined as logic operation above thermodynamic limit – employing reversible logic**
  - **Third tier**
    - **Quantum computing**

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- **Bader: Proposes truly noble application, to operate at 1 ZF**
- **CH Bennett: Reversible and quantum offer relevant upside potential, but may be difficult to implement and not fully general**
- **ITRS: Confident predictions 12 years out, but identifying potential problems**
- **Burger: Architecture for driving to power limits of transistors**

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- **Silver: Superconducting technologies are an option, due to low power and high speed**
- **Sterling: Discussion of architectural principles for advanced transistorized systems**
- **Keyes: Widespread need for Petaflops (and above)**
- **Jardin:**

- **Issue: Access to fab by US manufacturers**

- **Chairman's statement:**
  - Some technologies will require perfect nanoscale manufacturing (transistors). This will require exponentially more expensive fabs
  - Other technolgies avoid this problem through error-tolerant nanoscale manufacturing (molecular arrays) or avoiding nanoscale manufacturing altogether (quantum computing)

- **To program emerging multi-core processors will use "trickled down" supercomputer technology**
- **Current industry plans for device technology suggest performance limits to supercomputers**
  - **$100M → 100 Petaflops**
  - **$1M → 1 Petaflops**

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Performance

- **Substantial performance growth predicted by industry for transistors over the next 15 years seems plausible for everything from one chip devices to supercomputers**

- **New nanotech device technologies may offer substantial gains in density, some increase in performance**

- **Superconducting technologies may offer substantial benefits for applications able to support refrigerators**

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- **Zettaflops performance has been proposed incorporating reversible logic and molecular device and deserves more investigation. These technologies would offer an equal "boost" for smaller system, but with lower absolute performance levels (robots, PCs)**

- **Emerging technologies at research stage can be used, but the user community must learn how and whether each technology option can be used in a system**
  - **Including an evolution path for existing software**
- **Workshop covered superconducting, nanotech, reversible, and quantum technologies**