Highlights of the 50th HPC User Forum Meeting Boston MA September 9-11,2013

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EXIT

Overview

- Meeting Foci: Life Sciences & Quantum Computing
- Additional topics
  - Paypal, NSF, Pseudo-Random Number generation, Vendor updates, etc.
- IDC ROI Research, Market Update
- Celebrations of the 50th meeting
- See full agenda at: http://www.hpcuserforum.com/registration/boston2013/bostonagenda.pdf
- Presentations at:

  http://www.hpcuserforum.com/download.html

Disclaimer

- This is a short summary of what I got out of some talks. The original authors may not agree with my summary and I apologize to them in advance.

Drug Discovery

Jerome Baudry, University of Tennessee. Title:Drug Discovery at the Petascale: Opportunities and Challenges

- Protein screening and screening chemical (ligand) database against large number of proteins
- Obtained assistance from Oak Ridge National Lab to scale from 512 cores to 84672 cores and working on GPGPU
- Large output (exabytes) is becoming a bottleneck

Personalized Medicine

Accelerating Individual Treatments for Pediatric Cancer, Glen Otero, Dell

Dell Collaboration with T-GEN

Focus on underserved area of Blastoma in Children

Speed up entire process from tumor sample, mapping, RNA sequence analysis etc.

Designed reference hardware/software architecture for processing in a cloud

Parallel Pseudo-Random Number Generation

Raj Boppana, Ph.D.

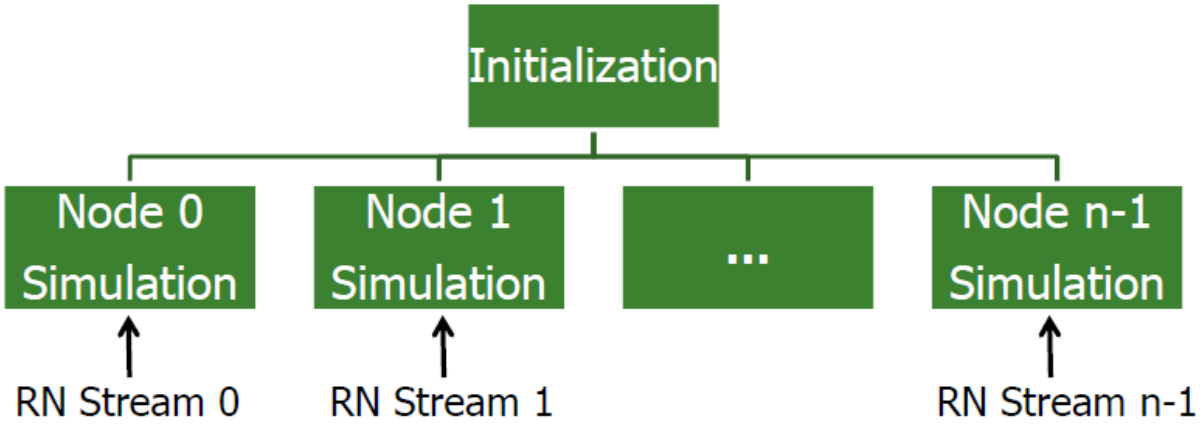
Professor and Interim Chair

Computer Science Department

University of Texas at San Antonio

- PRNG: parallel pseudo-random number generator
  - Provides multiple distinct RN streams

Mobile Ad Hoc Network Simulator



Context-aware parallel pseudorandom number generator (CPRNG)

Based on the Fibonacci recurrence:

$$x_n = x_{n-k} * x_{n-l} \pmod{2^{64}},\ 0 < k < l < n$$

Implementation: an include file + a small library module

Results Obtained

- **Context-aware parallel random number generator (CPRNG)** **[Patent pending]**
  - Virtually unlimited number of random number streams, each stream with a large cycle
  - Provides distinct streams based on the location of calls for RNs (user selectable; no app. recoding)
    - Reduces the impact of intrastream correlations
  - Dynamically allocates additional RN streams beyond any upper limit specified
    - Some large, complex simulations require unpredictable and very large number of RN streams for subtasks

Quantum Computing
Dinner speaker

Charles Bennett IBM Watson Research Center

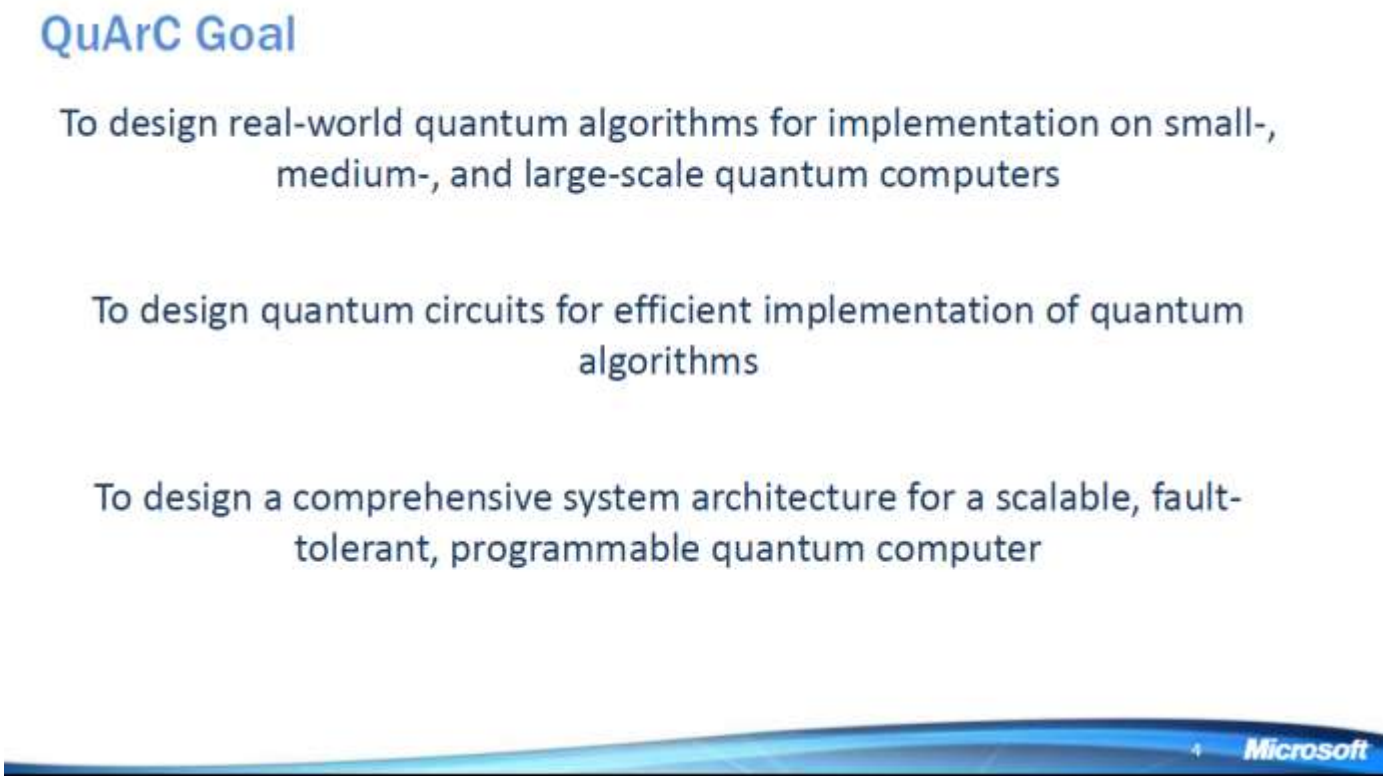
Computation & Civilization

- History of computing – bullae, fingers, writing, logarithms, slide rule, mechanical calculators etc.
- deterministic vs. non-deterministic
- Classical information like a book can be copied, Quantum information is like a dream where trying to describe the dream disturbs your memory of the dream
- http://www.hpcuserforum.com/presentations/boston2013/BennettHPCDinner.pdf

Quantum Computing Research at Microsoft

Dave Wecker

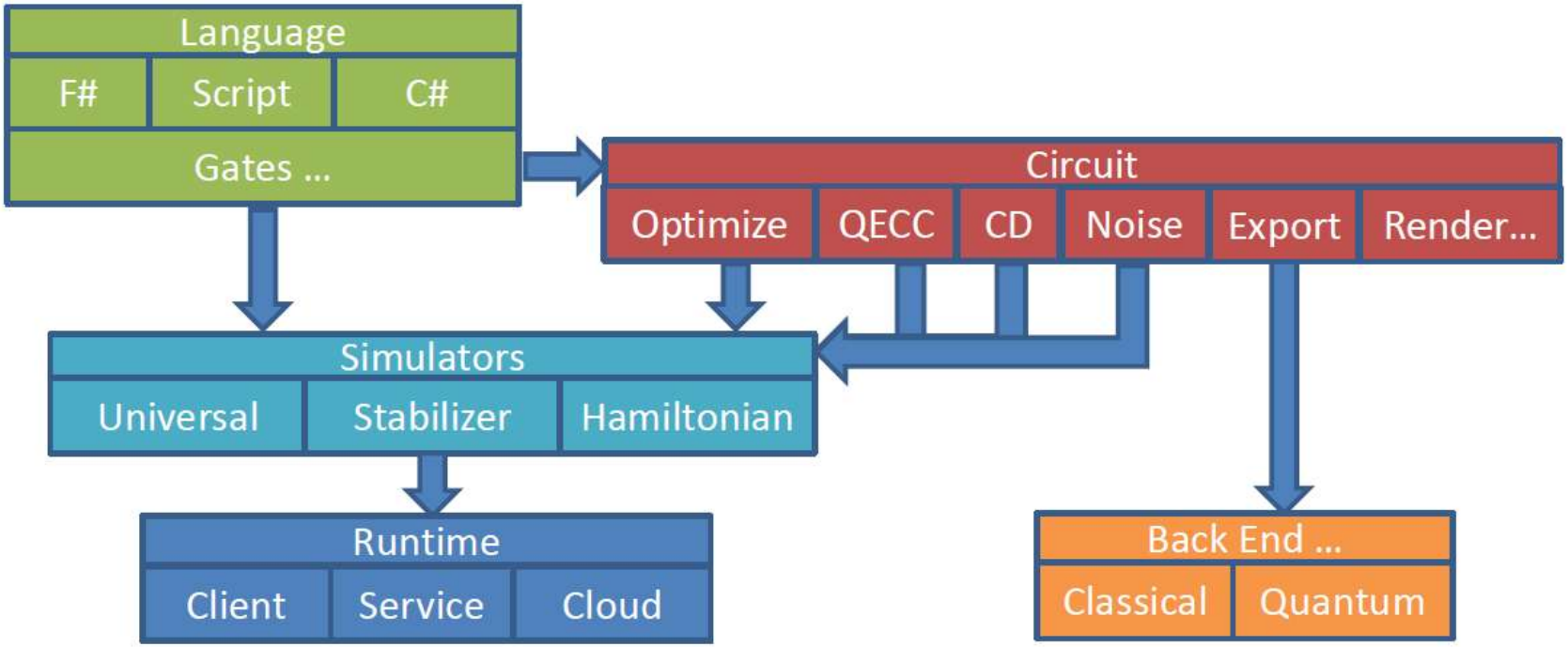
- 11 person QuArC Team led by Burton Smith



QuArC Areas of Research

- Quantum circuit synthesis
  - Efficient decomposition into Fibonacci anyon braids (Kliuchnikov, Bocharov, Svore)
  - Repeat-until-success circuits for extremely low-depth synthesis (Paetznick, Svore)
  - Efficient decomposition into V basis circuits (Bocharov, Gurevich, Svore)
  - Characterization of quantum state transformations using ancilla (Blass, Gurevich)
  - A canonical form for {H,T} single-qubit circuits (Bocharov, Svore)
- Quantum algorithms
  - Faster phase estimation (Svore, Hastings, Freedman)
  - Hubbard model (Wecker, Troyer, Hastings, Nayak, Clark)
  - Quantum chemistry (Wecker, Troyer)
  - Hamiltonian simulation (Wiebe, Wecker, Troyer)
  - 2D nearest-neighbor architecture to factor in polylog depth (Pham, Svore)
  - Classically simulating adiabatic algorithms (Hastings, Freedman , Troyer, Wecker)
  - Computational Complexity (Hastings, Freedman)
- Quantum error correction and distillation
  - Noise threshold for small-distance surface codes (Tomita, Svore)
  - Noise threshold for magic state distillation on topological architectures (Chen, Svore)
  - State distillation protocol to implement single-qubit gates (Duclos-Cianci, Svore)
  - Topological Computational Power (Hastings, Nayak, Freedman)
- **Quantum languages and platforms**
  - **LIQ$Ui|\rangle$ (Wecker, Geller, Smith, Svore, Bocharov)**
  - Quantum control architecture (Smith, Wecker, Geller)
  - Cold classical systems architecture, design and implementation (Smith, Wecker, Geller)

The LIQ$Ui|\rangle$ Platform



Microsoft

The D-Wave Two: A New Computer for Quantum Computing, Geordie Rose, D-Wave Systems

- Cold hardware - close to absolute 0
- VLSI processors using superconducting material, 512 qbits, 509 working on NASA/Google system
- Start with a Graph, output a bitstream
- Qbits are loops of metal with 2 states
- Edges of a Graph map to couplers connecting loops
- Compute using a weighted Max2 set (Ising model)
- Sample the output and get set of answers in decreasing probability of correctness

Want to know more? Ask Rupak ☺

Thank You

감사합니다