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Seminar Series Supported by Jeffrey and Holly Ullman

Alternative Computing Day
February 09, 2009

10:30 Coffee & Tagging

10:50 Opening Remarks

Gideon Arieli, Ministry of Science & Technology
Shlomi Arnon, Ben-Gurion University
Shlomi Dolev, Ben-Gurion University

11:00 Wavelength addressing, its physical implemenations, and its application in distributed computing networks.

Aharon Agranat, Hebrew University

Abstract:The fact that photons of different wavelengths do not interact can be exploited as a routing method by which each destination is allocated a specific wavelength. Thus, data packets transmitted at a given wavelength will reach their destination without the need for active routing operations along the way. However, simplistic implementation of wavelength addressing in a parallel computing network is ineffective due to its seemingly low scalability, high latency, and cost. It will be shown that these limitations can be obviated by applying the concepts of the laser power grid, and the ORTA multiplexing technique. The underline for the physical implementation of these concepts by using Electroholography will be outlined. Finally, architecture for a storage area network based on wavelength addressing will be shown.

11:55 Quantum Computation - where did we start, where are we going?

Dorit Aharonov, Hebrew University

Abstract: Everybody has heard about Shor's polynomial quantum algorithm for factoring. Not many are familiar with a line of exciting new quantum algorithms of the past few years, which, unlike Shor's algorithm, borrow their intuition from physics and apply it to problems of interest in various areas in science. The renewed connection between quantum computation and physics has also led to other exciting results ranging anywhere on the line between computer science and physics. I will provide a survey of old as well as new ideas in the area, starting from the very beginning: what is a quantum bit?

12:50 Lunch Break

13:50 Unguided Optical Communication Bus for Next Generation Computers

Shlomi Arnon, Ben Gurion University

Abstract: The importance of high-end computer (HEC) development lies in its ability to solve complex problems in many areas of science and engineering. In order to develop the next generation of HEC, faster buses are required. However, faster buses are potentially unaffordable or unachievable with the further scaling of today's electrical technology. Some of the parameters that prevent this further scaling include power dissipation, chip pin-out, RF interference, and clock propagation delay in addition to huge energy consumption. In order to overcome scaling limitations related to electrical buses, but without using cumbersome and bulky fiber optical links, the concept of unguided optical communication bus (UOCB) has been introduced. UOCB is a technology for transmitting information through material from one to many points without a waveguide while taking advantage of scattering and diffusion effects. This technology could be used as the optical infrastructure for a next generation computer mother board. But to extract the maximum potential of optical technology, mitigation algorithms for physical phenomena such as scattering and interference are required.

14:35 Asymmetric Chip Multi-Core: The future Chip Multiprocessor (CMP)

Uri Weiser, Technion

Abstract: Computational requirement is characterized by a wide range of diverse applications. This wide range of applications is applicable to all "PC" computing markets (e.g. Mobile, Desktop and Server). In many cases these applications coexist and run simultaneously on a specific system. The applications differ from each other by their practical requirements e.g. performance, BW, latency, power limitation, performance/power requirement, differential services etc. Essentially, these requirements differ from one application to the other (aka asymmetric) and call for reciprocal HW/OS implementation to enable a better response to the applications' need. On the other hand, device's power limitation will drive for Asymmetric HW. The diverse requirements and the change in HW calls for a new Asymmetric HW/OS approach. What should be HW/OS asymmetry approach? Should we start from applications' requirements? Data Content based requirements? What should the HW look like? Asymmetric Processing elements (cores) – same ISA/Different ISA?, how should the applications' Scheduling work ? In this talk we will try to open a small window to the Asymmetric world and present some aspects and solutions. The talk seeks to stimulate discussion, debate and future work.

5:30 Coffee

15:40 Optical Solutions for Bounded NP-Complete Problems

Shlomi Dolev, Ben Gurion University

Abstract: Architectures for optical processors designed to solve bounded instances of NP-Complete problems are suggested. One approach mimics the traveling salesman by traveling beams that simultaneously examine the different possible paths. The design allows solving primitives such as the Hamiltonian path, Clique, Independent Set, Vertex Cover, Partition, 3-SAT, 3D-matching and the Permanent. The second approach uses optical vector matrix multiplication, representing all possible Hamiltonian paths by a matrix in a doubling prepossessing stage and multiplying the matrix by the instance of graph to be considered. The talk summarize joint works with: Hen Fitoussi, Ephraim Korach, Stephane Messika, Yuval Nir, Joseph Rosen, Natan Shaked, Galit Uzan and Amir Anter

16:25 Molecular Syllogisms

Ehud Shapiro, Weizmann Institute

Abstract: Autonomous programmable computing devices made of biological molecules hold the promise of interacting with the biological environment in future biological and medical applications. Previously, molecular implementations of finite automata and logic gates were developed. Here we show an autonomous programmable molecular system capable of performing simple logical deductions. Using molecular representations of facts such as Man(Socrates) (Socrates is a Man) and rules such as Mortal(X)<--Man(X) (Every Man is Mortal), the system can answer molecular queries such as Mortal(Socrates)? (Is Socrates Mortal?) and Mortal(X)? (Who is Mortal?). This molecular computing system compares favorably with previous systems in terms of expressive power, performance and precision. A compiler translates facts, rules and queries into their molecular representations and subsequently operates a robotic system that realizes the logical deductions and delivers the result to the user. This hybrid electronic-molecular system represents the first high-level computer programming language with a molecular-scale implementation.

17:10 Learning from Bacteria about Information Processing

Eshel Ben-Jacob, Tel Aviv University

Abstract: Bacteria, the first and most fundamental of all organisms, lead rich social life in complex hierarchical communities. Collectively, they gather information from the environment, learn from past experience, and take decisions. Bacteria do not store genetically all the information required for efficient responding to all possible environmental conditions. To solve the new encountered problems (challenges) posed by the environment, they first asses the problem via collective sensing, recall stored information of past experience and then execute distributed information processing of the 109-12 bacteria in the colony thus turning the colony into super-brain. Super-brain, because the billions of bacteria in the colony use sophisticated communication strategies to link the intracellular computation networks of each bacterium (including signaling path ways of billions of molecules) into a network of networks. I will then show illuminating movies of swarming intelligence of live bacteria in which they solve optimization problems that are beyond what we, human being, can solve with our most powerful computers. This will lead me to a discussion about the special nature of bacteria computational principles in comparison to our Turing Algorithm computational principles. If time will permit, I will show that we can learn from the bacteria about our brain. In particular that the crucial role of the neglected other side of the brain - distributed information processing of the astrocytes.