Data Vortex® General Purpose Fine-Grained Parallel Computers:
Designed by a Mathematician for the Scientific Community to Solve the Hardest Problems

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A computer is a device that executes algorithms. In order to solve any problem whatsoever, there must be an algorithm whose execution produces a solution to the problem. In order to design a computer to solve a collection of problems efficiently, it is necessary to understand the set of algorithms associated with the collection of problems. Therefore, the design of an efficient computer necessarily involves the study of the target problem set and the associated set of algorithms.

Algorithms produce output as a function of input. A given algorithm A on a computer C operates on an input I and produces an output O = A(I). There are various performance measurements that can be applied to such a procedure. In many important cases, the algorithm performs well on certain inputs, but does not perform well on other inputs. It is an important goal of the computer architect to expand the class of inputs that algorithms handle efficiently. Many major classical algorithms, such as Euclid's algorithm, can be defined by a flow chart. In order for an algorithm to perform well, the computer must be efficient at moving data through that flow chart. For this reason, in a parallel computer connecting processors using a network structure, the performance depends on the network structure as well as the processor design.

Our computer study contains a number of target algorithms including: sparse matrix-vector multiply, graph search on computers holding large data sets, and Fourier Analyses. There is a single network solution that works for all of these (as well as many other) applications. We have named this solution the "Data Vortex" because data swirls through this network in vortex fashion. There is an interesting history concerning the discovery of this solution network.

During the 1930s and 1940s a group of Polish mathematicians met in the Scottish Café in Lwów to discuss mathematics. Probably at the suggestion of Stefan Banach, they kept a book of unsolved mathematical problems in a notebook now referred to as "The Scottish Book". Problem 110 in that book was formulated by Stanislaw Ulam in 1936. This problem received a certain amount of attention because J. von Neumann observed that an affirmative answer would follow for Hilbert's problem concerning the introduction of analytic parameters in n-parameter groups, the problem was solved in 1977 by Dr. Coke Reed and Dr. Krystyna Kuperberg. Dr. Kuperberg used the example as a starting point for settling the Seifert conjecture. Dr. Reed used the example as a starting point for the "Data Vortex", a dynamical system for carrying information rather than particles. The movement of data through the Data Vortex network will be described in this talk.

The Data Vortex network enables scientists to perform work on problems that rely on a tremendous flood of processor-to-processor communication, something that present-day computers handle quite poorly. For example, the Data Vortex is used to perform the FFT algorithm. In 1805, Karl Friedrich Gauss used the Fast Fourier Transform to determine the trajectories of the comets Pallas and Juno. It is of note that the original manuscript of Fourier on the subject of Fourier analyses appeared in 1807. The Gauss work describes the data flow of the transform. It is of interest that the Data Vortex computer enables this FFT data flow on a general purpose computer for the first time. This topic of FFT data flow as well as the general topic of data flow algorithms on Data Vortex computers will also be discussed.

Dr. Reed's talk will be followed by a brief overview of the Data Vortex family of high performance computers currently being manufactured by Plexus, Inc. This overview, given by Mr. Bill Stube, Data Vortex Project Manager for Plexus, Inc., will include a high-level description of the Data Vortex enabled system characteristics, performance comparisons to present-day leading supercomputer systems, and an overview of the simple programming model used by Data Vortex researchers to port their work onto Data Vortex computers.

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