ACM 82 PANEL SESSION

SUPERCOMPUTERS: CHALLENGES TO DESIGNERS AND USERS

Session Chairman and Moderator
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SESSION OVERVIEW: The objective of this panel is to present and discuss issues concerned with the development and use of present and future supercomputers for large-scale scientific and engineering problems. Presentations by each of four panelists will be followed by a question and answer session with audience participation. Below some brief background information is given on the subject matter along with a list of several topics that will be addressed. Also included is a bibliography to help the reader become acquainted with the many aspects of the session theme.

BACKGROUND INFORMATION

A supercomputer is a very fast machine which has architectural features to provide parallelism amongst a variety of scalar and vector arithmetic operations. Such processors can be very fast and are characterized by short clock times, large memories, long word lengths, large I/O bandwidths, and pipelining of several arithmetic operations. Such computers are currently capable of peak speeds well over 100 mflops (millions of floating-point operations per second) for vector-oriented problems; this compares with maximum rates of no more than 3 to 7 mflops for most large conventional (scalar) machines. Supercomputers have been evolving since the mid-1960's and include such earlier machines as the ILLIAC IV, CDC 7600, TI ASC, CDC STAR-100, and the BSP along with such current processors as the CRAY-1 (successor of CDC 7600) and the CDC Cyber 205 (successor of the CDC STAR-100).

The number-crunching capabilities exhibited by supercomputers are beneficial for the solution of a wide variety of applications, particularly 2-D and 3-D simulation problems such as are encountered in petroleum research, fluid dynamics, weather forecasting, aerospace design, structural analysis, nuclear research, etc. Such problems require numerical solutions which involve extensive amounts of vector and matrix floating-point operations and thus cannot be handled efficiently by conventional scalar machines which do not possess any vector processing facility. There are approximately 50 supercomputers in the field and these are located at government and industrial research laboratories, in a few computer service bureaus, at several universities, and in a growing number of industrial sites.

The amount and type of parallelism amongst vector and scalar operations can vary greatly from one supercomputer to another. Unfortunately, most programs do not approach peak speeds by solely automatic means (preprocessors, vectorizing compilers) and can require significant algorithmic and/or programming modification. Performance on a supercomputer is both problem and data dependent. Several factors can degrade performance on a specific machine: vector length (too long, too short, variable), domination of scalar operations over vector operations, too much program modularity (e.g. too many short subroutines), operations involving sparse matrices, extensive amounts of indirect addressing, extensive branching, too much I/O processing.

TOPICS FOR DISCUSSION

Some of the issues to be discussed and which have impact on both designers and users include the following (bibliographic references are given for each topic): user-oriented, high-level languages for supercomputers [1, 10, 15, 25, 34]; vectorizing techniques via user actions [8, 14, 18, 19]; preprocessors and compilers for vector machines [6, 20, 22]; parallel algorithm design [11, 13, 15, 16, 17, 25, 36, 39]; tradeoffs between vector and scalar performance [2, 15, 36, 37, 42]; CRAY-1 and Cyber 205 performance [7, 11, 15, 16, 26]; parallelism in architecture [2, 3, 4, 5, 8, 9, 10, 11, 12, 15, 21, 23, 24, 25, 27, 38, 40, 41, 42]; use of array processors

[15, 25, 31, 32]; potential of new technologies [15, 33, 35]; design tradeoffs [28, 29, 30].

PANELISTS

For this session, I have selected individuals with extensive experience in the design and/or use of past and present supercomputers. The participants, their affiliations, and addresses are given below:

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