

Where Do We Go from Here? My Thoughts on Computer Architecture

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Abstract:

During my forty years of work in the field of computer architecture I have been privileged to contribute in areas that I believe are increasingly relevant to the evolution of computer architecture from its present doldrums. In the early 1960s I advocated and helped develop the combination of paging and segmentation used in the addressing mechanisms of the GE 645 computer used by Project MAC in the Multics time-sharing operating system. This supported a degree of power in building software from existing components that had not been seen before and has not been seen since. Starting around 1965 I led a research group that developed dataflow concepts of computer architecture and inspired a dozen or more projects around the world including two commercial products by NEC in Japan. The Monsoon project of my MIT colleague, Prof. Arvind, demonstrated that typical scientific codes offer abundant parallelism that can be exploited by a fine-grain parallel computer designed using dataflow principles. In 1979 my group designed a pure functional programming language for scientific computation that became the SISAL programming language of the Lawrence Livermore Laboratory (LLL). The Sisal group at LLL demonstrated that the language could be used to map computations to existing multiprocessor computers with far less effort and opportunity for error than using Fortran, and with comparable performance. A study at NASA's RIACS group confirmed that the combination of dataflow architecture with the Sisal functional language would yield attractive advantages for the several significant scientific codes covered by the study.

Given the need to move to multiprocessor computers to benefit further from the advance of silicon technology, and given the continuing dismal state of programming methodologies for developing software for these machines, it is time for some real innovation that explores important ideas that have been ignored all too long. I will provide an overview of a multiprocessor chip I have been working on that is an example of the sort of advanced computer architecture I envision.