A Very True High Performance Computing Machine for Fluid Mechanics

-Today and Beyond-

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Abstract

This presentation exploits a very true high performance computer for fluid mechanics rethinking of von Neumann computers in terms of computer architecture. So far fluid mechanics researchers have used a vector supercomputer as one of HPC (High Performance Computing) systems. The processing speed was not more than 1 Peta-FLOPS. However, the faster the processing speed is the more conveniently large scale computing in fluid mechanics could realize.

The innovation in computer architecture will have been expected especially these days because the increase in speed would be apt to saturate along with Moor's law in hardware (transistors) density. It is high time we had a novel architecture to jump up to the next processing speed range. This presentation especially emphasizes the improvement of von Neumann computers in order to obtain more than 1 Peta-FLOPS as very true HPC systems.

For users especially of fluid mechanics, old software has to rather than might be used in view of user-friendly and inexpensive interface. Neumann type programs with lots of statements are dialog language for the researchers educated with such languages, so that existing programming languages should be kept usable.

Fortunately a novel architecture has been discovered and now developing even with today's conventional technologies from devices to software level under old software. The feature of this architecture is a victory of an innovation of von Neumann computer by introducing a novel memory, Streaming Memory that has functions of not only information/data storage but also its conveyance.

The innovation has changed von Neumann computers from with the memory bottleneck to without it. Today the speed of the CPU is 100times faster than that of conventional memory, so that computer systems have memory bottleneck, so called the memory wall today.

Fortunately, the novel memory behaves as if water flows on the memory plane smoothly. Therefore, it is not necessary to access the streaming memory, which fact means an interesting point that there is no addressing before Read/Write a location in the memory. Further all the information is streaming in the memory, so that it is also not necessary to refresh them as in DRAMs'.

These features cause less circuitry for the two operations, and fortunately no signal time delay and no heat problems then at lower cost. As the structure and procedure for the streaming memory operation are quite simple, the speed of the streaming memory could reach that of the CPU. Then computer systems without the memory bottleneck are 100 times faster than conventional ones.

Further, the hardware size of computers without the memory bottleneck shrinks to be 1/100 times as large as old one. Keeping the same implementation size as old ones, we can provide 100 times more hardware than old ones.

As a result, the performance expectation of the new computer with the streaming memory and then without the memory bottleneck is 10,000 times faster than that of existing von Neumann computer even in high performance computing systems category.