

## Tilburg University

### The road map to Tera

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### THE ROAD MAP TO TERA

Once DEEP BLUE had beaten World Champion Kasparov, many felt that chess no longer provided a real research challenge and that the research scope should be broadened, towards other games and applications. IBM, the financial father of DEEP BLUE, did so by selecting special applications for their RS6000 supercomputer. Speed was no longer expressed in micro-seconds, but in nano-seconds; storage no longer in MBytes but in GBytes. Commercially they have a product that sells itself. Meanwhile the computer-chess world has become too small for them. It is with some regret that we remark that neither DEEP BLUE nor DEEP BLUE JR. will be participating in the 9<sup>th</sup> World Computer-Chess Championship to be held in Paderborn, Germany.

After the retirement of CRAY BLITZ, DEEP BLUE is the second supercomputer program to leave the computer-chess scene. Has the development of supercomputers stopped? Are there no new increases of speed and storage to be expected? The answer is no. All reputable supercomputer vendors are busy making ambitious plans for the new century. Their line of reasoning is that the 1970s stands for kilo, the 1980s for mega, the 1990s for giga and that after 2000 comes tera. Some of them are even announcing that in the year 2002 their machines will operate at 30 TFlops. This means  $30 \times 10^{12}$  floating points operations per second. Without any doubt the ply depth of computer-chess programs which may use such a machine will increase considerably. Hence new findings will emerge and to all it will be clear that computer-chess research has not come to an end. But what will the impact of the tera development be? First of all, the storage capacity will grow analogously: memory will be expressed in TBytes. Second, machines with less memory or with cache memory insufficient for the task at hand will use advanced compression techniques, especially if space is an obstacle and time is not.

A closer investigation of the future developments brings three completely distinct contrasts to light: time versus space, heuristics versus proven facts, and vector processing versus parallelism. The time-versus-space issue has a recurrent nature. Depending on the progress of technology we see a balance swing in the trade-off between both issues. Currently storage is the major obstacle. In the pages of this Journal we read that Wirth and Nievergelt need 42 CD ROMs to save their findings, and that Heinz uses a special compression technique to make the 3-piece and 4-piece databases suitable for the main memory of his machine.

This last issue brings up the fundamental question whether using heuristics, i.e., potentially sacrificing correctness, is a true sign of scientific progress. The following example may illustrate this question. Some twelve years ago, the computer-chess research group of the Delft University of Technology built the first 6-piece endgame database using heuristics, viz. KRP(a2)KbBP(a3). For the world of chess, especially for those Grandmasters interested in Timman-Velimirovic, it was a breakthrough. For some researchers in the computer-chess world too, but not for

all. One of the founding fathers of chess endgame databases, Ken Thompson, once gave as his view: "I am not sure that my temperament allows me to do something where I am really not sure of the answer. I think that I have to do it from first principles, the 6 pieces with the two Pawns." This issue of the Journal deals with the above-mentioned fundamental question. The Editorial Board and the referees believe that heuristic approaches also constitute true science and as a sign of progress the contributions are included.

The next challenge is to prove that the heuristics are true. For this purpose we need faster machines and more storage. Here we arrive at the third contrast. Will vector processing bring the required increase of speed? Or are we dependent on parallelism and if so, what are the bounds? On the road map of the supercomputer vendors we vaguely saw that tera was followed by peta ( $10^{15}$ ) and exa ( $10^{18}$ ). No dates were mentioned. As to the unit of speed per instruction the road map was even more vague: after nano-seconds and pico-seconds we found femto-seconds ( $10^{-15}$ ), and atto-seconds ( $10^{-18}$ ). The 21<sup>st</sup> century has not yet started, but the large-scale road maps have been printed and the only question remaining seems taken directly from chess-tournament competition: who will be the first to arrive at the next milestone? This and other topics will be discussed at the ACC9 Conference in Paderborn. I look forward to meeting all of you there.

Jaap van den Herik