

Panel Discussion

Where Will Processor Performance Come From in the Next Ten Years?

Moderator: Krste Asanvic, MIT, Cambridge

Panelists:

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| • Fred Weber | AMD |
| • Joel Emer | Compaq Computer Corp. |
| • Hiroshi Iwai | Tokyo Institute of Technology |
| • Frank Fox | Rambus Inc. |
| • Wen-Mei Hwu | University of Illinois at Urbana-Champaign |
| • William Dally | Stanford University |
| • Fred Pollack | Intel Corp. |

Overview: 100x microprocessor performance improvement in 1990-2000

Questions:

- Another 100x performance improvement in 2000-2010?
- If so, how much each from process technology, circuit design, computer architecture, compiler technology?

Answer:

- Most says it is possible
 - combination of improvement in all areas of microprocessor design
 - super-scalar technique is the key
- Disagree on how much each area contributes and which area will contribute the most
 - Hardware (H)
 - Compiling (C)
- Hardware poll:
 - Lot of room for improvement or optimization in hardware
 - Enough for the next 10 years
 - At least, 10x improvement can be reached
 - Mr. Weber, Mr. Pollack and Mr. Emer are strong supporters.
- Compiling poll:
 - Up to 20x improvement can be done on compiling alone
 - Better algorithms can be found in the architecture to boost the performance
 - Lot of improvement in optimizing the compiler and high-level language interface
 - Little attention in the past
 - Mr. Hwu and Mr. Dally are strong supporters for this poll.

- **Mr. Dally's observation (C): improvement limitation in hardware**

- The higher-frequency the microprocessor operates, the more delay in communication from one end of the chip to the other
- For correctness and high-speed, need to operate distributedly
- Need more complex architectures and algorithms
- Mr. Emer (H) agrees to Mr. Dally's view in principle, but says not for now
 - No solid evidence is found yet
 - By clever design techniques, hardware can guarantee the correctness even at high speed

- **Mr. Hwu (C): compiling development deserves more attention**

- Exist software bugs in compilers which can hardly detect and pop up now and then during hardware verification process
- Such bugs can be mistaken as hardware failures and can waste lot of design debug efforts to find out
- No comments from the hardware group

- **Mr. Iwai (more in hardware): no further room for improvement by 2010**

- Unless some new break-through in technology takes place
- Most panelists do not share that pessimistic view.

Conclusion

- The hardware poll:
 - mostly no estimation in compiling improvement
 - 10x improvement or more in hardware alone
- The compiling poll:
 - An overall improvement of 100x is possible
 - ~20x in compiling optimization
 - ~5x in hardware
- Don't be so surprised if the performance is even better in 2010!