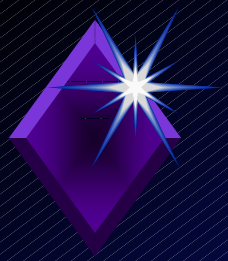
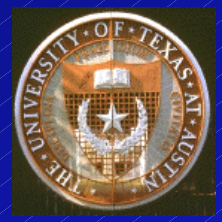


Embedded Software Systems



Programmable VLIW and SIMD architectures for DSP and Multimedia Applications

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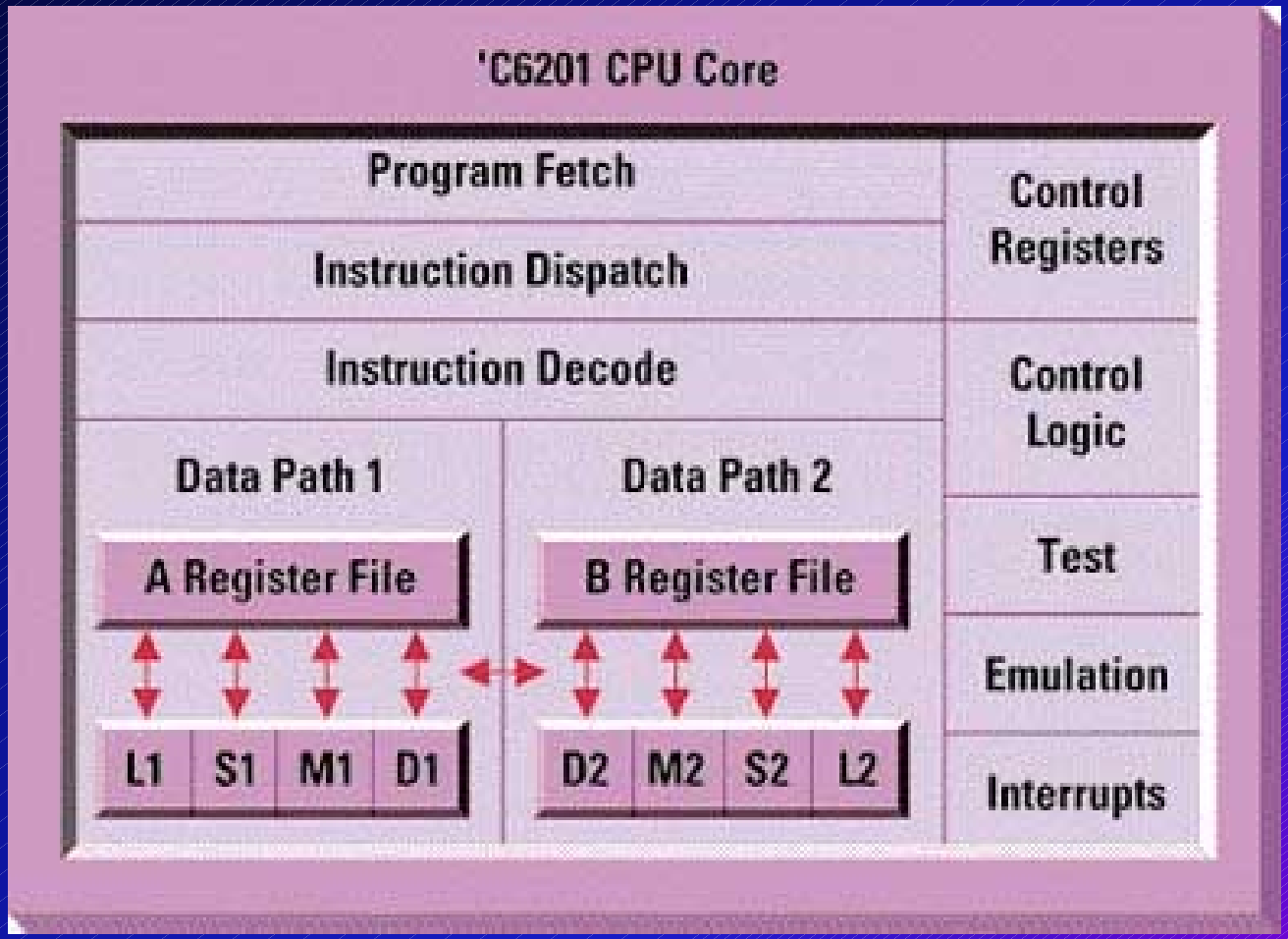
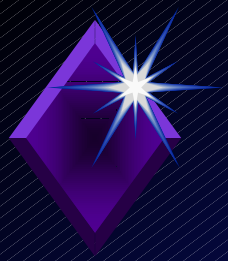
VLIW Processors

- Very Long Instruction Word
- Single Instruction specifies more than one concurrent operation
  - Instruction width is quite large taking many bits to encode multiple operations
  - Rely on software to pack the collection of operations (Compaction)
  - In code with limited instruction parallelism, most of the instruction is wasted with no operations
- TI's TMS320C6x series, Analog Device's TigerSHARC* and Lucent+Motorola's StarCore

VLIW Processors (continued…)

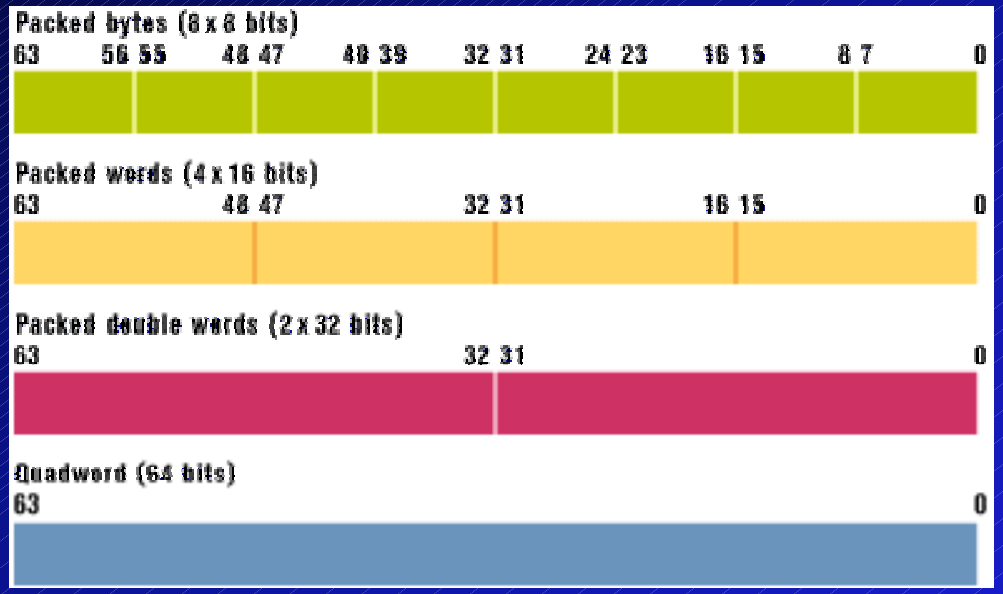


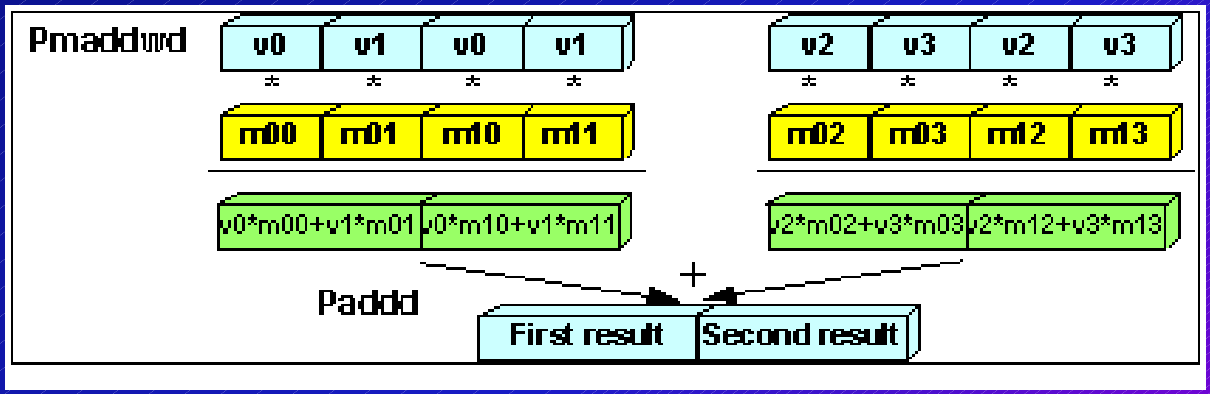


SIMD Processors

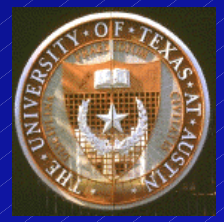
- Single Instruction Multiple Data
- Exploit data parallelism as opposed to instruction parallelism in VLIW processors
- A technique that has been added to general-purpose processors for DSP and multimedia processing
  - Intel's MMX, Sun's VIS, Motorola's AltiVec

SIMD Processors (continued…)





Motivation/What's the deal?

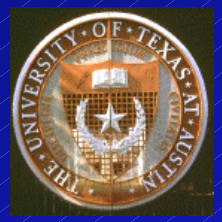


- Over 90% of future workloads are expected to be multimedia oriented
- Multimedia applications have good instruction and data parallelism -> VLIW and SIMD are a good bet
- Very few existing literature on evaluation of such applications
- Have to benchmark important kernels and complete applications

Frequently asked Q & A !!

- What is it that is being evaluated?
  - Evaluate a VLIW representative and a SIMD representative -> C6x and Pentium II (MMX)
- What are the benchmarks that will be used?
  - DSP and multimedia kernels and applications (more details in a later slide)
- What are the tools that will used?
  - For the C6x -> C6x compiler, Stand-alone simulator, and the simulator & debugger
  - For the Pentium II -> VTune and Performance Counters

Frequently asked Q & A !! (continued...)



- What would be final conclusion? Something like the C6x is better than Pentium II or vice versa!
  - C6x is meant for low cost embedded solutions while the Pentium II is a general-purpose processor for PC/desktop use
    - Comparison would be between apples and oranges
    - Either processor is not a replacement for the other
    - Which is why the title is “SIMD and VLIW” and not “SIMD vs VLIW”!
  - The goal is to evaluate two techniques using one representative processor for each

Frequently asked Q & A !! (continued...)

- Are these two techniques not orthogonal?
  - Yes, they are and both can be implemented in a single processor -> ADI's TigerSHARC is something like that
  - We might see more processors like that in the future, but for now the idea is to use the state-of-the-art processors using one of these techniques
  - Therefore, this is not a comparison between a DSP and a general-purpose processor in the strict sense, but surely some insight can be gained into high-performance DSPs versus high-purpose general-purpose processors

Benchmarks

- **Kernels**
  - Dot-product, matrix-vector products
  - FIR and IIR filters
  - FFT and DCT
- **Applications**
  - Speech compression algorithms (G.721, 722, 723..)
  - Image Processing applications (JPEG, GIF, blurring..)
  - 3D graphics
  - Video processing (MPEG, H.261, 263..)

Methodology

- Use relevant C code and respective compilers and evaluate metrics of interest (execution time, number of instructions..)
- But MMX instructions are not generated by compilers in general -> try CodeWarrior
- Resort to libraries where ever applicable (this means optimized assembly)

References

[1] R. Bhargava, L. John, B. Evans and R. Radhakrishnan, "Evaluating MMX Technology Using DSP and Multimedia Applications", *Proceedings of IEEE Micro-31*, Dec 1998.

[2] P. Ranganathan, S. Adve and N. Jouppi, "Performance of Image and Video Processing with General-Purpose Processors and Media ISA Extensions", *To appear in Proceedings of International Symposium on Computer Architecture-26*, 1999.

[3] C. Lee, M. Potkonjak and W.H. Mangione-Smith, "MediaBench: A Tool for Evaluating and Synthesizing Multimedia and Communications Systems", *Proceedings of IEEE Micro-30*, Dec 1997.

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