Extending Processor Models in the Cmpware CMP-DK

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The Cmpware CMP-DK

- Multiprocessor / multicore software and architecture development environment
- A powerful interactive software development
- Fast, flexible modeling
- CPU model 'plugs in' to provide rich set of displays and tools
- Integrates with existing compilers (gcc)
- Eclipse based
The Cmpware CMP-DK

CPU Compiler / Tools

Source Code
Profiler

Instr. Trace

Link Traffic

Memory Dump

Dasm

ELF / DWARF Loader

Cmpware Multiprocessor Simulation Engine

CPU Model

Network Model

Link Model

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Extending the Processor Model

- New models can *inherit* existing models
- New instructions easily added
- Other functionality easily added, too
- A new model with new instruction in approximately 5 lines of code (;)
- Models can be mixed (heterogeneous)

==> A powerful way to explore customized processors / multiprocessors
The **MIPS32EX Extended Model**

```java
public class MIPS32EX extends MIPS32 {

    public static void main(String[] args) {
        AutoModel.main(new MIPS32EX(), args);
    } /* end main() */

    /** The constructor */
    public MIPS32EX() {
        defineName("MIPS32EX");
        defineInstructions(newInstructions);
        reset();
    } /* end MIPS32EX() */

    /** The XNOR instruction */
    private final class XNOR implements Function {
        public void exec(Processor p) {
            r[rd] = ~(r[rs] ^ r[rt]);
        } /* end exec() */
    } /* end class XNOR */

    /** The XNOR instruction decode information */
    private final static Decode newi_decode = Decode.primary(op, 0x18);

    /** The new XNOR instruction definition */
    private final Instruction newInstructions[] = {
        new Instruction("xnor", regToReg, newi_decode, new XNOR())
    };

} /* end class MIPS32EX */
```

- **MIPS32EX** 'extends' **MIPS32**
- Add new instruction(s)
- Define new XNOR instruction
- Define XNOR decode
- The new instruction definition(s)
Model-Driven Tools

- Assembler and disassembler automatically extracted from model data
  - Assists in verifying new models
  - Tools always in sync with architecture
  - Can be integrated into other tools
- 'Free' tool support for extension instructions
- Example:
  - XNOR instruction added to MIPS32
  - Produces MIPS32EX model assembler / disassembler
MIPS32 has no XNOR instruction

MIPS32EX has XNOR instruction
A MIPS32EX + MIPS32 Design
The *MIPS32* Processor

Register Values (Note r4 = xor(r4, r1))

Disassembly (note no XNOR)
The MIPS32EX Processor

Register Values
(Note r5 = xnor(r5, r1))

Disassembly (note XNOR)
Conclusions

- Processor models for the Cmpware CMP-DK easily extended
- Extended models provide:
  - Assembler
  - Disassembler
  - IDE integration

\[\Rightarrow\] Customized processors and tools easily produced and modified