



System-level Stimuli Generation for the CELL Processor

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Agenda

Results

- ♦ The CELL architecture (again)
- System-level verification challenges
- A system-level stimuli generation solution: X-Gen



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The CELL Processor **x8** SPU SPU PPE . . . LS MFC LS MFC L2 EIB **BIC / IOC** IOC MIC BFM Model **IOIF BFM** Memory

To another CELL / to IO

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System verification background: where we come from

Mainline system development in IBM

- Power based eServers: pSeries (UNIX), OpenPower (Linux), iSeries (previously known as AS/400)
 Based on Power3, Power4, Power4+, Power5, ...
- PowerPC 970 based systems (blades, Apple)
- Mainframes: zSeries (previously S/390)

System verification

- Processor centric
- A highly complex memory sub-system: coherency and consistency issues
- ♦ Systems are not tied to a single software application



POWER5



Challenge #1: heterogeneous processors

♦ A single PPE

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♦ Dual thread, 64-bit, PowerPC processor

Eight SPEs

Synergetic Processing Element
128-bit wide vector processor

- Other high-end systems in IBM are homogeneous
 Typically multi-processor PowerPC systems
- Some MP-oriented verification tools cannot be used



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Challenge #2: non-processor translation mechanism

- The PowerPC address translation mechanism is highly complex
- ♦ Supported by:
 - The PPE A PowerPCThe MFC essentially a DMA
- These mechanisms are usually wellverified before the system-level

♦Using state-of-the-art processor verification tools

But: the MFC is not a processor

♦ Some of the load was passed to the system level

→ Required SL tools to go into finer details



Figure 16. Translation of \$0-bit virtual address to 62-bit real address





Challenges 3, 4, and 5

♦ A completely new architecture

Combines of relative instability and high complexity

Coherency and consistency are still crucial: the PPE, SPEs are all coherent

The CELL is general purpose

- Doesn't aim at a single software application
- As opposed to more application specific SoCs

As in high-end systems





Simulation-based functional verification





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System-level stimuli generation solution

- X-Gen: the same tool is used for high-end servers, the CELL, and other designs
- Reuse from other systems:
 Abstract system model: >40%
 Test requests: ~30%
- Possible due to the model-based test-generation paradigm
- Dummy configurations were used for verification in addition to 1xPPE – 8xSPE

♦All with the same set of test requests







CELL System verification results

- ♦ Close to 150 bugs exposed
- I spoke about stimuli generation: there's also checking, coverage, verification execution, ...





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