PS3GRID.net

Building a distributed supercomputer using the Playstation 3

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Introduction

- Playstation 3 (PS3) Game Console
- Cell Processor
- Molecular Dynamic (MD)
- CellMD
- Berkeley Open Infrastructure for Network Computing (BOINC)
Playstation 3

- Sony’s game consoles launched in 2006
- Distinguished by technical capabilities and innovative design
- Powered by Cell Processor
- Cheap High-performance Computing
- Grid of Playstation 3
Problems

- Reliability and Trust
- No control to PS3s - all devices is transient
- Error correction from incomplete simulation
- Defective hardware or malicious users

- Loose coupling
  - General-purpose ethernet network - bandwidth problem
Cell Processor

- Developed by Sony, Toshiba and IBM
- 1 POWER™ processing element (PPE)
- 8 Synergetic Processing Element (SPEs)
- Main memory can be accessed only by PPE
- SPE must use limited in-chip local memory of 256 KB.
- Element Interconnect Bus (EIB): interconnecting 8 SPEs in high speed and memory-coherent
- Integrated Memory Controller (MIC): connected to external RAMBUS XDR memory
Cell Processor

Figure: Cell Processor Block Diagram

Cell Processor

- Each core (PPE or SPE) features Single Instruction Multiple Data (SIMD)
- SPEs in total can perform 230 GFLOPS for single precision floating-point operation
- Elements of SPE:
  - Synergetic Processing Unit: data processing core
  - Memory Flow Controller (MFC): handles communication between main and local memory
  - 1 SPU can handle 4 single precision floating point operation simultaneously
Cell Processor

Figure: SPE block diagram

Molecular Dynamic

• Modeling very large molecular systems at an atomic level.

• Each atom interacts with all the others within a certain radius.

• Cut-off distance between 10-12 Å (10^{-10} meters)

• Each steps is 1 femtosecond (10^{-15} seconds)

• For PS3Grid, use simple model of a single Gramicidin-A pore in a biological cell
CellMD

- Cell Processor => codes do not automatically run faster.
- CellMD => optimized for Cell processor
- Vectorization of compute-intensive code
- Work distribution using multi-threaded programming techniques.
- Avoid brancing => no hardware for branch prediction
CellMD

- Comparing MD running on 2GHz Opteron PC with CellMD running on IBM Cell Blade server.

- Speedup is approximately 19 times for many different atoms size.

- Benchmark result for 30,000 atom Gramicidin-A model on 2Ghz Opteron PC, IBM Cell blade server, PS3 using 1, 2, 4 and 6 SPEs.
PS3Grid Server

- Berkeley Open Infrastructure Network Computing (BOINC) based
- Provides end-to-end distributed computing infrastructure
  - Generic User Authentication
  - File transfer
  - Client-side: wrapper for the project application
  - Work-flow management function
PS3Grid Client

- Yellow Dog Linux (YDL) on Playstation 3 + BOINC Client

- Steps:
  1. Get Instructions
  2. Download application and input data
  3. Compute
  4. Upload output files
  5. Report results
Results

• Generate a computational power of 300 personal computers.

• Sustained floating-point performance of 400 GFLOPS.

• 5 GB of Data

• 100 ns of meluclar dynamics trajectories

• Over 6 years of computation by a single PC

• All this in approximately 1 month!

Figure: Simulation of Gramicidin A
Conclusion

• CellMD performs one order of magnitude faster than MD

• CellMD and BOINC can compete with expensive multiprocessor high performance computers.

• Opening possibility of High Performance Network Computing.
Next Implementation

• GPU Grid
• Using Nvidia Graphics Card
• Implementing CUDA
Question?