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

PlayStation.

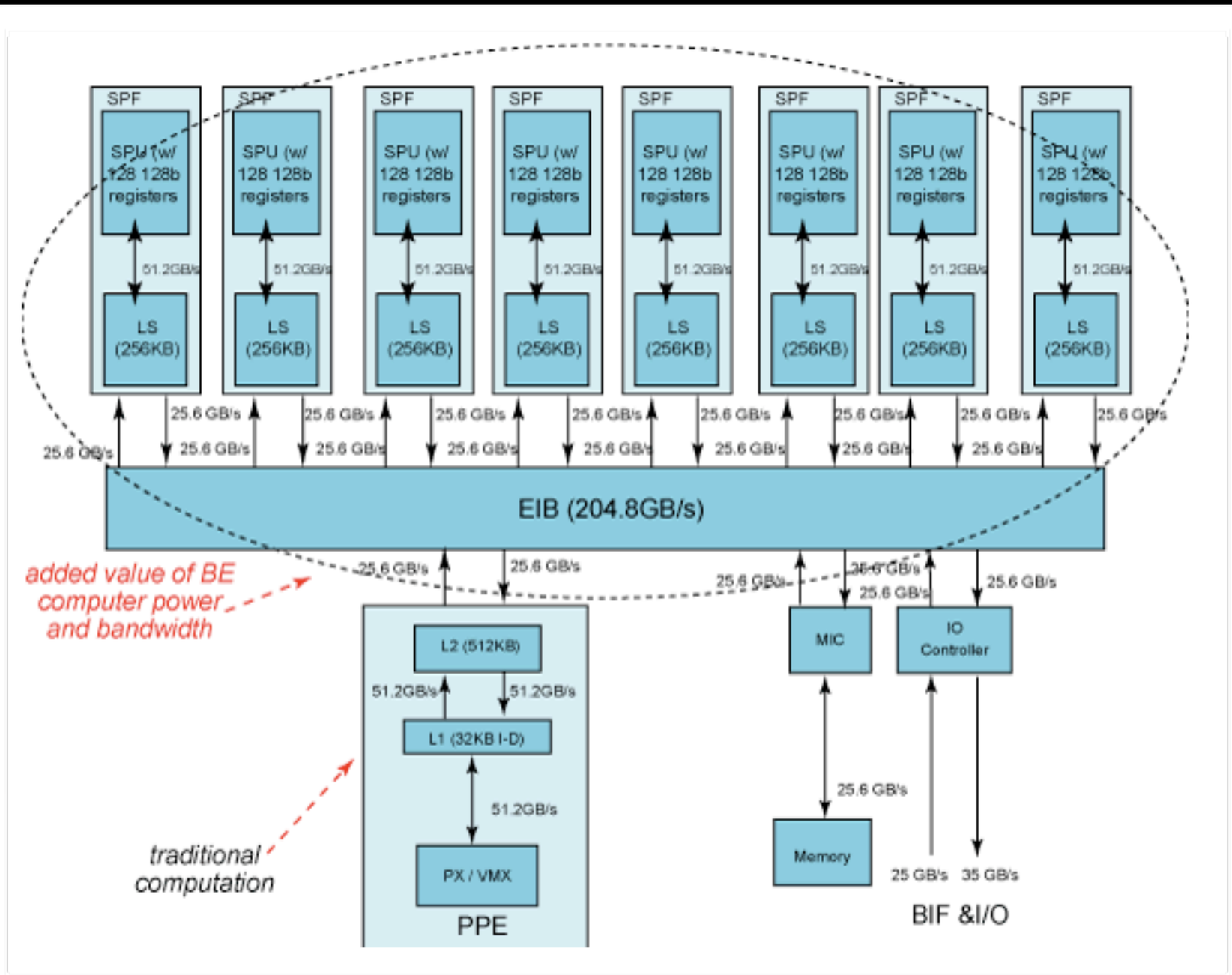


Figure: Cell Processor Block Diagram

Courtesy of http://www.ibm.com/developerworks/library/pa-cellperf/

Cell Processor

- Each core (PPE or SPE) features Single Instruction Multiple Data (SIMD)
- SPEs in total can performs 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

PLAYSTATION 3

PlayStation.

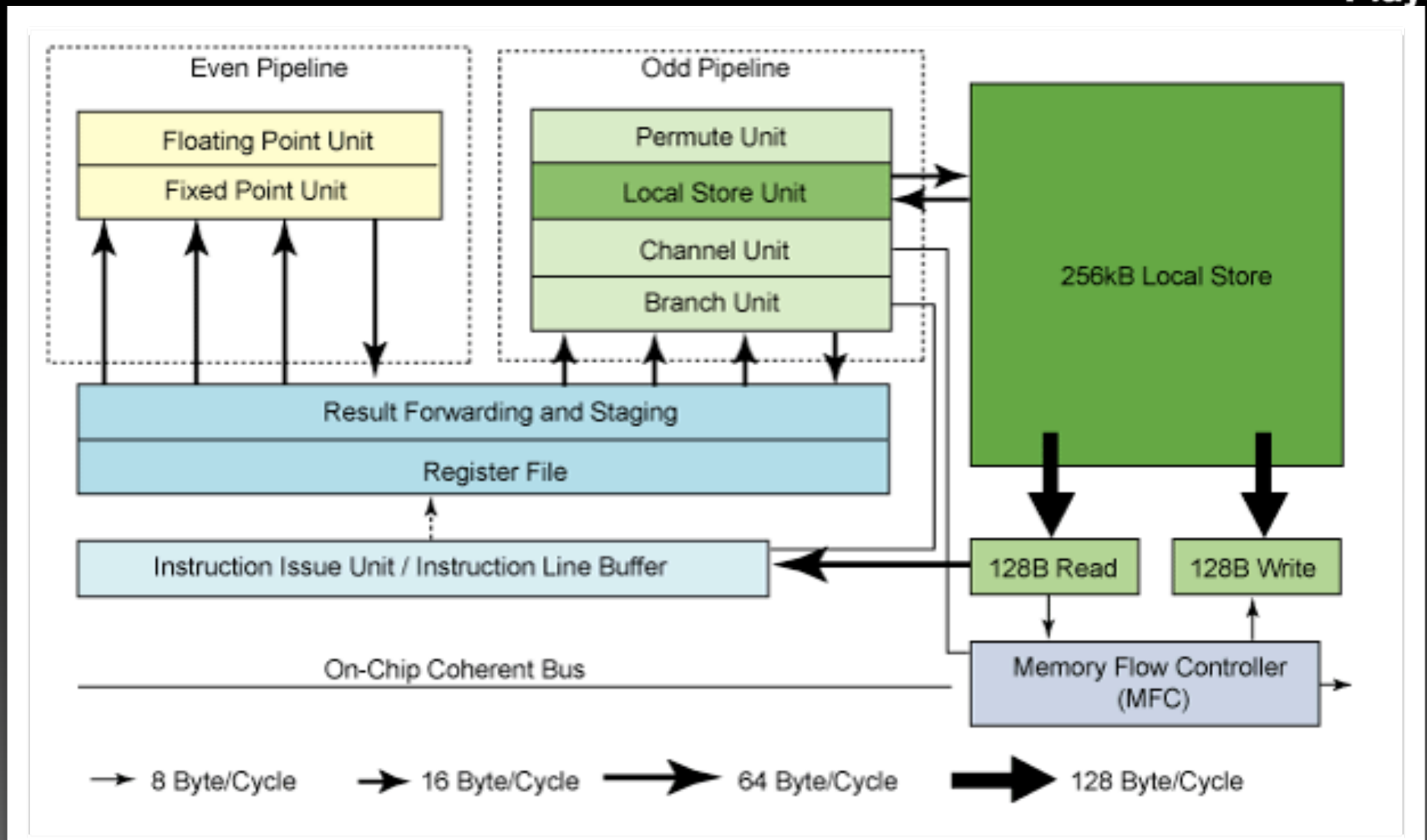


Figure: SPE block diagram

Courtesy of http://www.ibm.com/developerworks/library/pa-cellperf/

Molecular Dynamic

PlayStation.

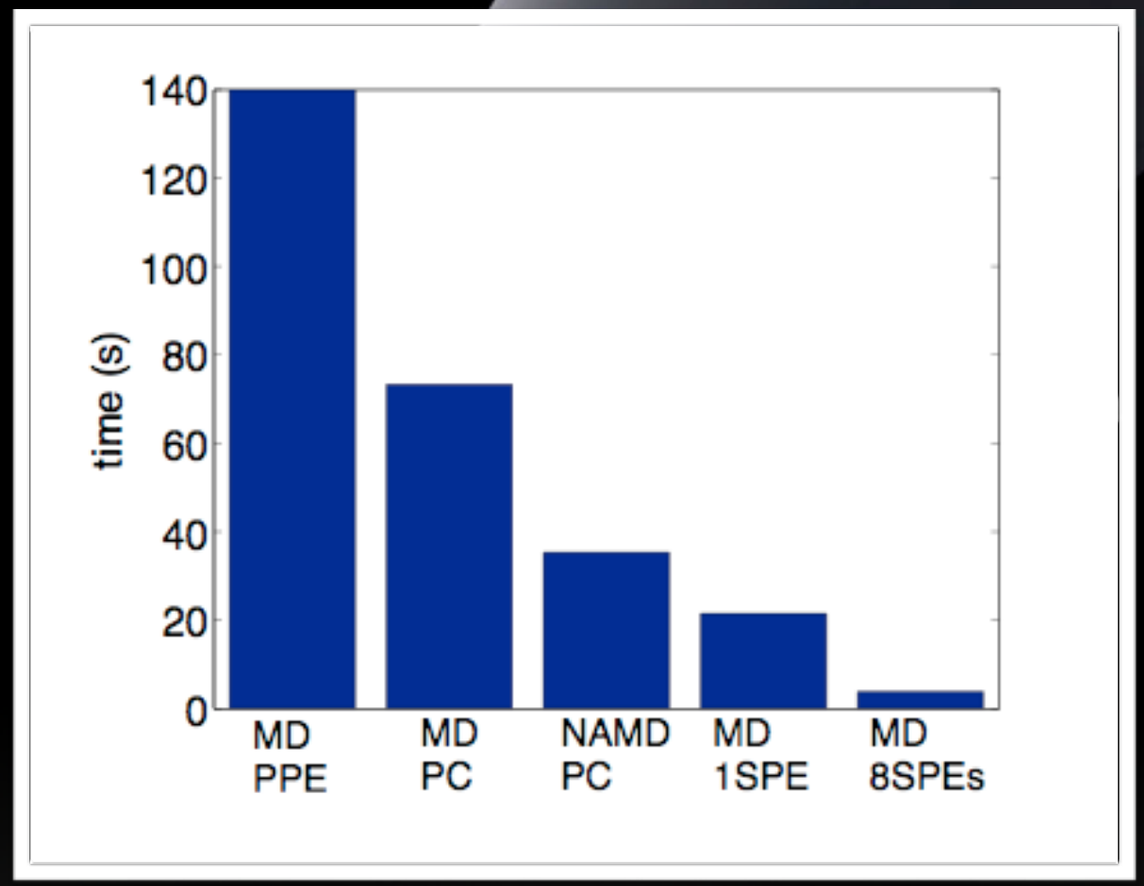
- Modeling very large molecular systems at an atomic level.
- Each atom interacts with all the others within a certain radius.
- Cut-off distance between 10-12 Å (10^{-10} meters)
- Each steps is 1 femtosecond (10^{-15}seconds)
- For PS3Grid, use simple model of a single Gramicidin-A pore in a biological 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

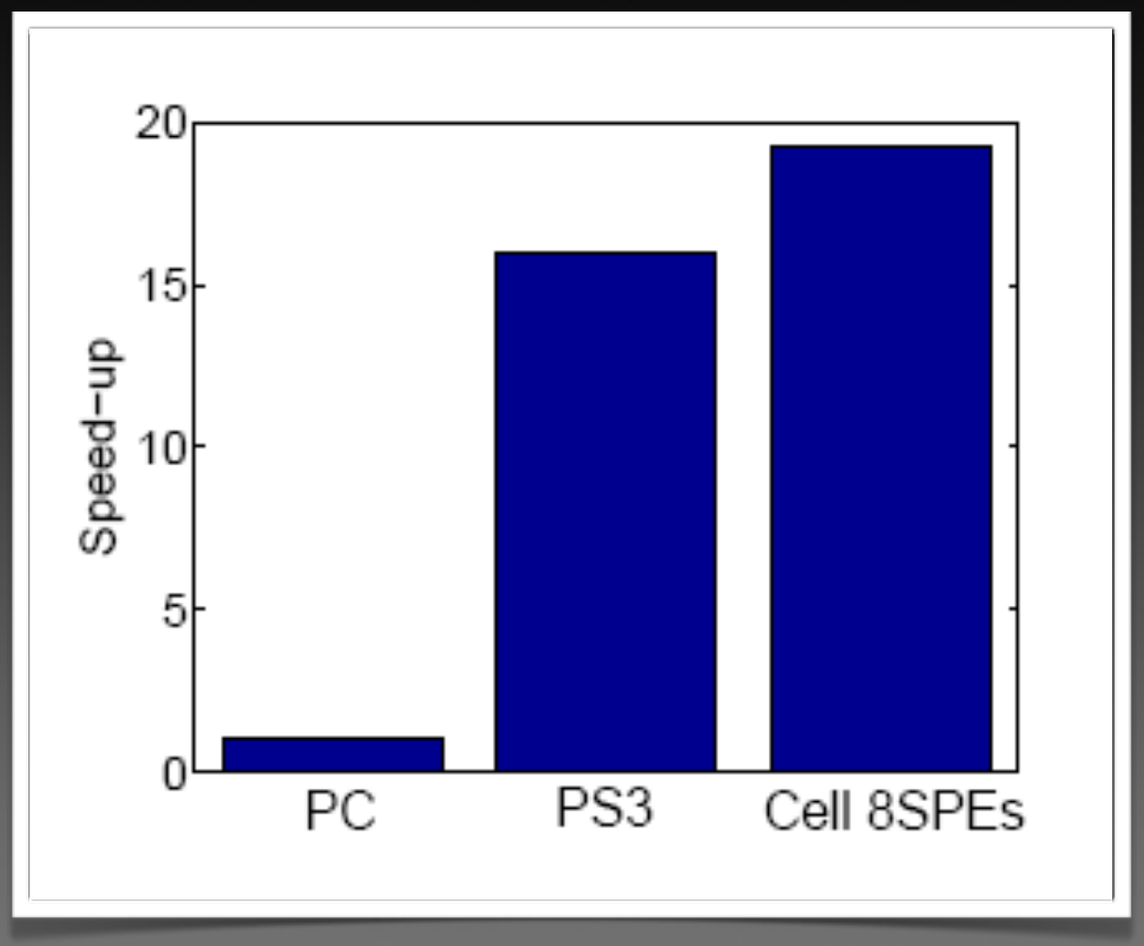
CellMD

- 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.



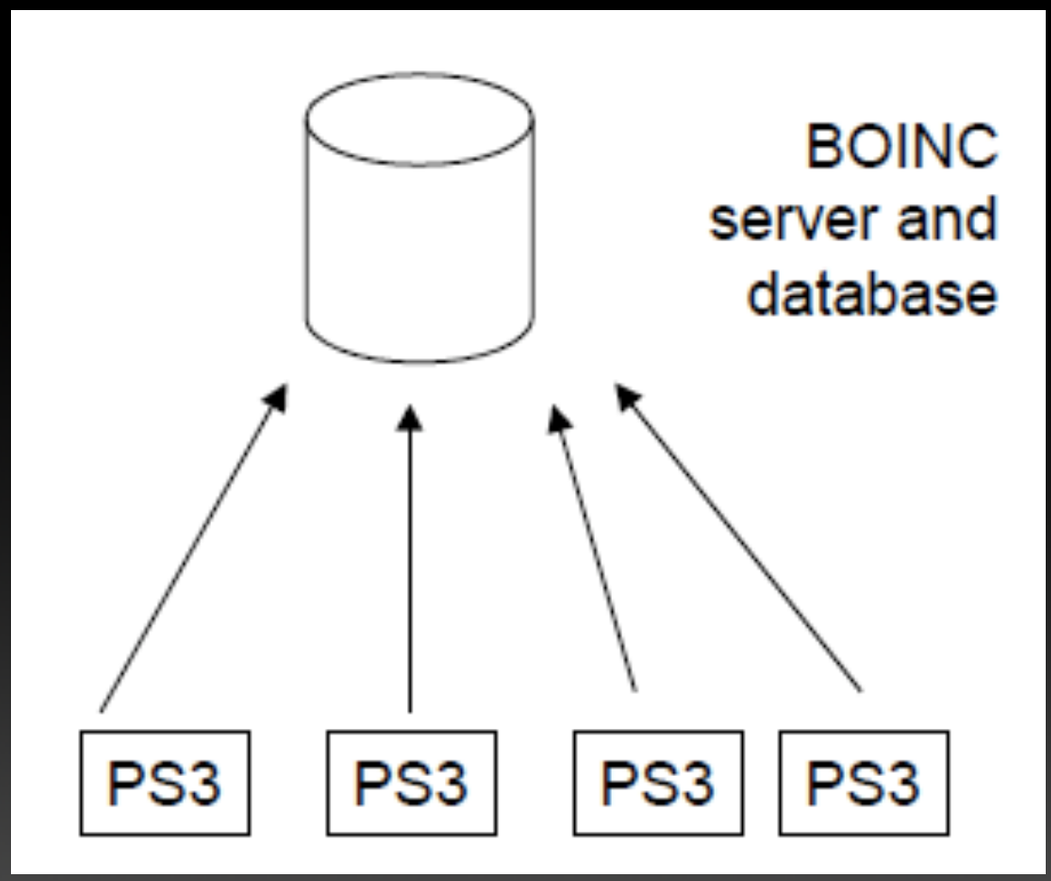
PS3Grid Server

- 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!

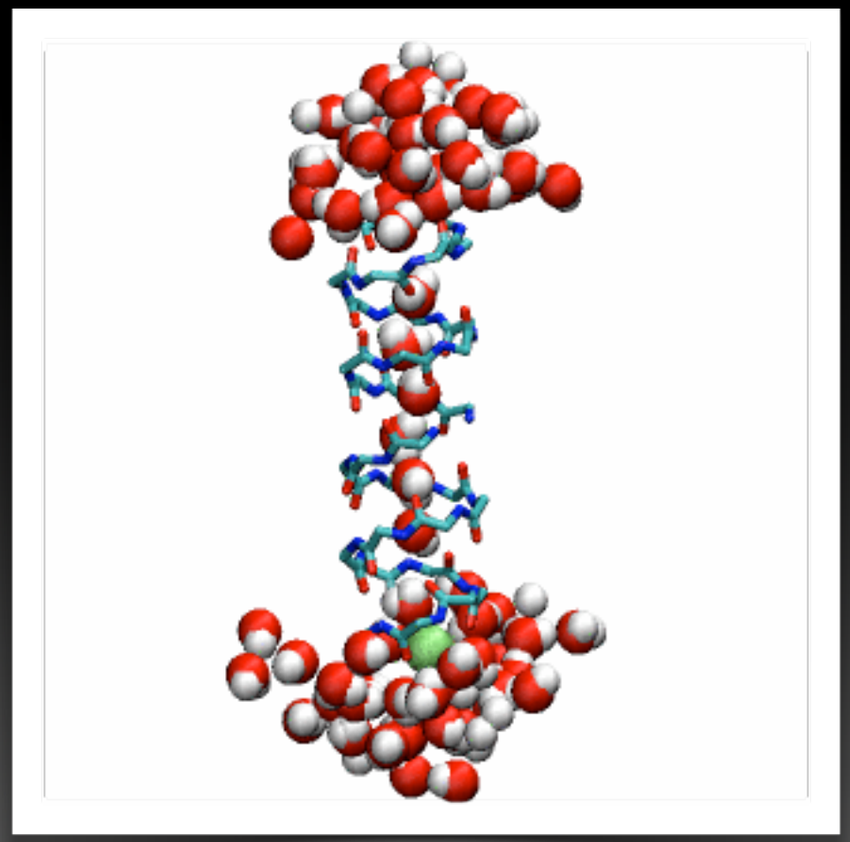


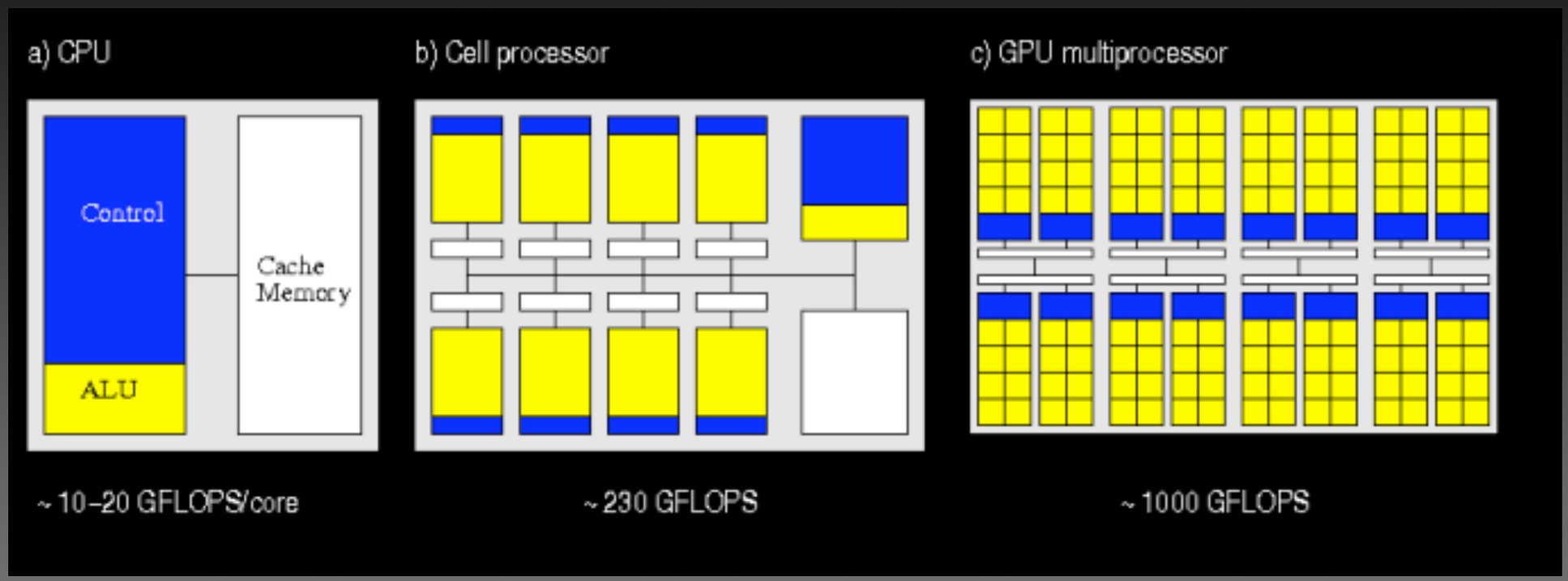
Figure: Simulation of Gramicidin A

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?