SX-Aurora TSUBASA

June 25, 2018
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History of Vector computing

NEC has always provided high sustained performance by vector supercomputer SX series

Performance

1990
1990
Earth Simulator
Earth Simulator
Earth Simulator
Earth Simulator 3
Earth Simulator 2
Earth Simulator
 SX-2
 SX-4
 SX-3
 SX-5
 SX-6
 SX-7
 SX-8
 SX-9
 SX-ACE

Vector Engine (PCI card)

Packed vector technologies accumulated over 30 years into PCI card
Project Aurora

Vector Accelerator Card
✓ NEC’s 30 years vector technology is packed into Vector Engine card

- Compact and flexible
- Hybrid architecture (standard x86 + Vector)
- Economically deliver supercomputer technology
New Architecture

- SX-Aurora TSUBASA = Standard x86 + Vector Engine
- Linux + standard language (Fortran/C/C++)
- Enjoy high performance with easy programming

SX-Aurora TSUBASA Architecture

Hardware
- Standard x86 server + Vector Engine

Software
- Linux OS
- Automatic vectorization compiler
- Fortran/C/C++ → No special programming like CUDA

Interconnect
- InfiniBand for MPI
- VE-VE direct communication support

Easy programming (standard language) → Automatic vectorization compiler → Enjoy high performance
New Architecture

Hybrid architecture combining Vector Processor with x86 Processor
1. SX-Aurora = x86 server + Vector Engine (VE)
2. VE capability is provided on x86/Linux environment
3. Infiniband Interconnect support

SX-Aurora Architecture

Linux OS

x86 Processor

Application

PCIe

Vector Engine

Enables the flexibility

Hardware

- x86 server + VE

Software Environment

- x86 / Linux OS
- Fortran/C/C++ standard programming
- Automatic vectorization by proven vector compiler

Interconnect

- InfiniBand for MPI

NO special programming like CUDA is necessary!
NEC’s Vector technology can invent new Social Values - as the key to accelerate HPC + AI/Big Data Analytics

Financial/Economics

Life

Security

Energy

Manufacturing

Disaster management

Progress of analysis/science

Statistical analysis

Image analysis

Acoustic analysis

Genetic

Geophysical

Fluid analysis

AI/BigData Analytics

Weather Climate

Structural analysis

Simulation (HPC)
Initial BM results: HPL and STREAM

- Aurora provides same range HPL performance as SKL
- Aurora provides highest memory bandwidth

**HPL / Node**

- Aurora is Vector Engine Type 10-B (1.4GHz, 8core)
- SKL is Intel Skylake 6148 Xeon x2/node
- KNL is Intel Knight Landing x1/node
- V100 is NVIDIA Tesla V100 x1/node
Initial BM results: HPCG

Performance/power of Aurora shows 7 times better than SKL

• Aurora is Vector Engine Type 10-B (1.4GHz, 8core)
• SKL is Intel Skylake 6148 Xeon x2/node
### Performance of NEC middleware for ML

**Frovedis + VE shows over 100x performance compared to Spark + x86**

<table>
<thead>
<tr>
<th></th>
<th>Spark + x86</th>
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<th>Frovedis + VE</th>
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<tbody>
<tr>
<td>Logistic Regression (web ad)</td>
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<td>42.8</td>
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<td>K-means (document clustering)</td>
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<td>56.8</td>
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<td>Singular value decomposition (recommendation)</td>
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<td>42.8</td>
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<td>56.8</td>
</tr>
</tbody>
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- x86: Intel Xeon Gold 6126 x1 socket
- Aurora: Vector Engine Type 10-B (1.4GHz, 8core) x1
- Performance comparison does not include I/O time