Early Evaluation of a New Vector Processor SX-Aurora TSUBASA

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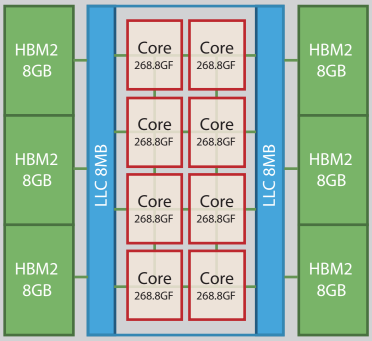
Overview of SX-Aurora TSUBASA

SX-Aurora TSUBASA vector processor can provide a high memory bandwidth for practical HPC applications.

- **High computational performance** by a 8-core vector processor
- **High sustained memory bandwidth** by six HBM2 memory modules integration
- **High usability** by a new execution model that an application is executed on a Vector Engine (**VE**) while system calls are offloaded to a Vector Host(**VH**)



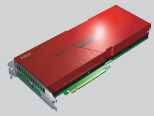
CPU・Memory Implementation

Process technology	: 16 nm FF
CPU size	: 33 x 15 mm
Memory implementation	: 6x HBM2
Development	: TSMC, NEC, Broadcom

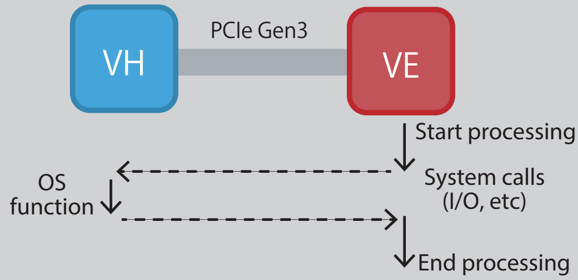
SX-Aurora TSUBASA concept: Easy to USE

- Standard Linux environment
- Standard Fortran/C/C++ languages
- Automatic vectorization / OpenMP
- Automatic parallelization

→ x86 node (VH) is attached to VE

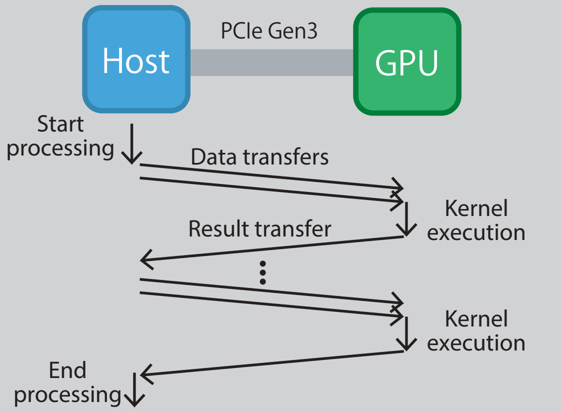


SX-Aurora TSUBASA execution model



Data transfer bottleneck among VH and VE can be avoided

Conventional accelerator execution model



Data transfers easily become bottleneck

Experimental Environments

Vector Engine: SX-Aurora TSUBASA Type 10B

- Peak performance	: 2.15 TFlop/s
- CPU Frequency	: 1.4 GHz
- Memory bandwidth	: 1.22 TB/s
- Memory capacity	: 48 GB
- LLC bandwidth	: 3.0 TB/s
- Maximum vector length	: 256

Vector Host: Intel Xeon Gold 6126

- Peak Performance	: 998.4 / 1420 GFlop/s
- CPU frequency	: 2.6 / 3.7 GHz
- Memory bandwidth	: 128 GB/s
- Memory capacity	: 96 GB
- Maximum AVX length	: 8

Benchmark programs

- Stream benchmark
- Himeno benchmark

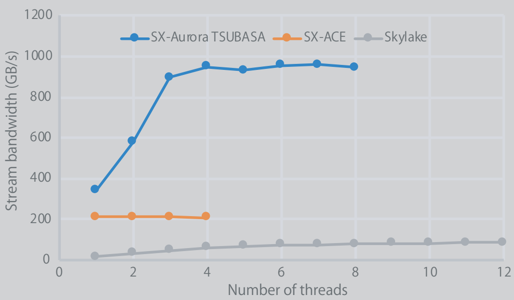
Practical application kernels

- Antenna: 3D FDTD (1.72 B/F)
- Earthquake: Ocean plates (2.0 B/F)
- Land Mine: 3D FDTD (7.69 B/F)
- Turbine: CFD, LU-SGS (1.14 B/F)

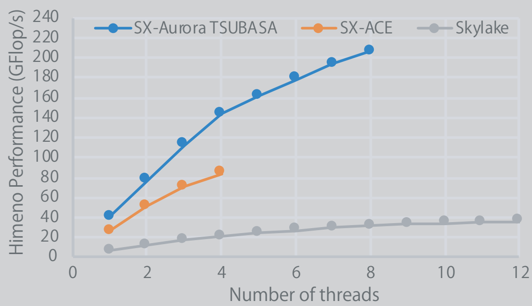
Software environments

- CentOS Linux 7.3.1611
- NEC Fortran compiler 0.0.26
- NEC C/C++ compiler 0.0.26
- Intel compiler 18.0.1

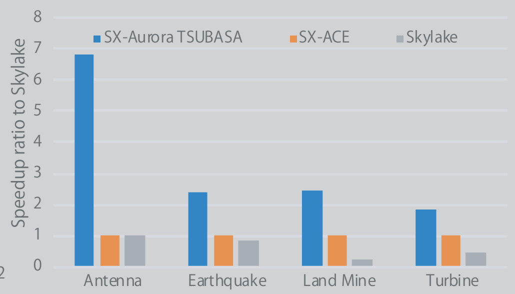
Performance Evaluation



SX-Aurora TSUBASA achieves about 961TB/s
- About 4.5 and 11.2 times higher bandwidth than SX-ACE and Xeon, respectively.



SX-Aurora TSUBASA achieves higher performance and better scalability up to the maximum number of threads than the others.



SX-Aurora TSUBASA achieves about 1.8 to 6.8 times faster than SX-ACE due to its high computational capability and high sustained memory bandwidth.

Conclusions

SX-Aurora TSUBASA has a high potential to accelerate various applications by its vector computational capability and high sustained memory bandwidth. The balance between memory performance and core performance is important to achieve high sustained performance.