Early Evaluation of the SX-ACE Processor
Ryusuke Egawa\textsuperscript{a, d}, Shintaro Momose\textsuperscript{b, a}, Kazuhiro Komatsu\textsuperscript{a, d}, Yoko Isobe\textsuperscript{b, a}, Akihiro Musa\textsuperscript{b, a}, Hiroyuki Takizawa\textsuperscript{a, d}, and Hiroaki Kobayashi\textsuperscript{a, c}
\textsuperscript{a}Cyberscience Center, Tohoku University, \textsuperscript{b}NEC Corporation, \textsuperscript{c}GIS Tohoku University, \textsuperscript{d}JST CREST

Background & Motivation
In November 2013, inheriting the advantages of conventional vector processors, SX-ACE has been launched to provide a high memory bandwidth commensurate with its high computational capability. The SX-ACE processor is designed so as to achieve:

1. A high sustained memory bandwidth for accelerating memory-intensive applications.
2. A high single core performance for obtaining a high sustained performance with fewer cores, under the limited power and silicon budgets.

However, the potential of SX-ACE for practical applications is not clear.

Objective:
Unveiling the potential of the SX-ACE processor using practical applications!

An Overview of the SX-ACE Processor
The SX-ACE processor employs a multi-vector-core architecture, which provides a high memory bandwidth with a high computational performance. As the successor of SX-9, SX-ACE introduces several architectural features as follows:

1. A multi-vector-core architecture
2. ADB and MSHR mechanisms to keep a high sustained memory bandwidth
3. Out of order vector memory access mechanisms to improve the performance of indirect/store memory accesses.
4. A shorter memory access latency and a shorter vector pipeline latency in chaining to realize efficient short-vector processing

Specifications
- ADB (Assignable Data Buffer)
- MSHR (Multiple Store Holding Register)

Out-of-order Vector Memory Access Mechanisms
- Core Scalability on the SX-ACE Processor
- Performance Evaluation of Various Processors

Benchmark Programs
- Performance of Short Vector Processing
- The memory subsystem's behavior, the out-of-order memory access operations, the direct memory access test system, and the test of the 3D graphics processing capability

Evaluation of the SX-ACE Processor
The SX-ACE processor provides the highest sustained performance in the tier.

Potential of SX-ACE

Conclusions and Future Work
To clarify a new generation vector processor, SX-ACE, this paper examines the sustained performance of the SX-ACE processor using practical scientific and engineering applications. Evaluation results indicate that the SX-ACE processor has significant advantages against modern scalar processors and conventional vector processors. The newly introduced advanced memory subsystem, which works with MSHR and out of order memory access functions, effectively accelerates memory-intensive applications with indirect memory accesses and stride memory accesses. In addition, inheriting the advantages of conventional vector processor, the SX-ACE processor achieves a higher sustained performance on processing short vector operation by shortening the memory access latencies and the chaining operation latencies.

Our future work includes performance evaluation of the multi-node system, power evaluation, and performance comparison with GPUs/accelerators.