SX-Aurora TSUBASA (Vector Engine)

Brand-new Vector Supercomputing power in Server Chassis

Deepak Pathania, OEM Alliance
High Bytes per FLOPs or Evolving towards massive data processing

- Vector Processor
- Memory Performance
- Crash Simulation
- Weather Simulation
- Multipurpose Processor
- Simulation
- Compute Performance
- Massively Parallel Processor (GPGPU)
- Voice Recognition
- Image Recognition
- Demand Forecasting
- Price Forecasting
- Recommendation
- AI
- Computing Performance

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High Bytes per FLOP’s Targeted Roadmap

Compute Performance

Vector Engine

Aurora 3

Aurora 2

Aurora 1

CPU

GPU

Memory Performance
Vector Processor on Card
(World’s Highest Memory Bandwidth Processor)

- New Developed Vector Processor (Derived from Super-Computer)
- PCIe Card Implementation
- 8 cores / processor
- 2.15TF performance (double precision)
- 1.2TB/s memory bandwidth, 48GB memory
- Normal programming with Fortran/C/C++
Core Architecture

- Memory (48GB)
- Cache (16MB)
- Vector register, 256e x 64 (128kB)
- Single core
- Vector Pipeline x 32
- VPU (Vector Processing Unit)

SPU (Scalar Processing Unit)

- VFMA0
- VFMA1
- VFMA2
- ALU0
- ALU1
- DIV

1.2TB/s / processor  400GB/s / core
(Ave. 150GB/s / core)
Materials for Learning and Training
- Tuning guides and various manuals

VEOS or middleware
- Heterogeneous Computing with Vectors

ML Libraries in C/C++
- Frovedis Library or Spark alike machine learning framework in C/C++

Deep Learning using Vectors

C/C++ Compiler
- ISO/IEC 14882:2014 (aka C++14)

Fortran Compiler

Open MP and MPI
- Version 4.5

Libraries
- Glibc
- MPI version 3.1 (fully tuned for Vector Engine Architecture
- NLC Libraries (BLAS, LAPACK, FFT etc.)

Tools
- FtraceViewer/PROGINF
- Gprof
- GDB, Eclipse Parallel Tools Platform
Ease of Programming

Automatic Vectorization feature and various tools help in vectorization for advance levels

```c
void matmul(float *A, float *B, float *C, int l, int m, int n){
    int i, j, k;
    for (i = 0; i < l; i++) {
        for (j = 0; j < n; j++) {
            float sum = 0.0;
            for (k = 0; k < m; k++)
                sum += A[i * m + k] * B[k * n + j];
            C[i*n+j] = sum;
        }
    }
}

void alloc_matrix(float **m_h, int h, int w){
    *m_h = (float *)malloc(sizeof(float) * h * w);
}

// other function definitions ...

int main(int argc, char *argv[]){
    float *Ah, *Bh, *Ch;
    struct timeval t1, t2;
    // prepare matrix A
    alloc_matrix(&Ah, L, M);
    // do it again for matrix B
    alloc_matrix(&Bh, M, N);
    // allocate spaces for matrix C
    alloc_matrix(&Ch, L, N);
    // call matmul function
    matmul(Ah, Bh, Ch, L, M, N);
    return 0;
}
```

Compiler diagnostic message:

```bash
$ ncc sample.c -O4 -report-all -fdiag-vector=2
ncc: opt(1589): sample.c, line 11: Outer loop moved inside inner loop(s): j
ncc: vec(101): sample.c, line 11: Vectorized loop.
```

No modification is necessary for vectorization

Just compile, and loops are vectorized automatically
VEOS offload models

Run the application in the right way possible using VEOS

Study Reference: https://www.hpc.nec/api/v1/forum/file/download?id=LbGhNY
Vectors for Weather

NEC received a 50 Million Euro order from the Deutscher Wetterdienst (DWD) for a highly innovative European weather forecasting system using NEC SX-Aurora TSUBASA

“The system combines forecasting based on observations with very demanding numerical weather prediction models in order for a more precise prediction of the development and the tracks of such small-scale weather events up to twelve hours into the future. This will enable better and earlier warnings for local populations,”

said Mr. Detlev Majewski, Head of the Department of Meteorological Analysis and Numerical Modelling at the Deutscher Wetterdienst.

Source: NEC Press Release

Vectors for Material Science

NEC SX-Aurora TSUBASA installed by High Energy Accelerator Research Organization, and National Institute for Environmental Studies for successive vector supercomputer systems, Japan

“The organization promotes simulation research in high energy physics, and introduced SX-Aurora TSUBASA to implement the joint use program "Primary Particle Nuclear Space Simulation Program".”

Says KEK (High Energy Accelerator Research Organization)

Source: NEC Press Release
NEC and HPE join forces in an Exclusive partnership
Vector optimized expertise meets Global HPC leader

- 30+ years in Vector compute architecture
- Silicon to software design expertise
- Optimized software stack
  - Compiler
  - SDK
  - Libraries

- #1 HPC Market Share *
- Global market coverage
- Purpose built server portfolio
- Strong ISV partner eco-system throughout the world
- Specialized HPC expertise
  - System management and operation
  - Benchmarking
  - Solution integration
  - Hybrid infrastructure
NEC and Colfax partner to provide groundbreaking HPC development at your desk

- Over 30 years of experience in delivering custom and HPC solutions
- Extensive customer base especially academia and research labs
- Specialized HPC expertise
  - Solution design and development
  - HPC research and training
  - Hybrid system design
- NEC and Colfax partnership aims to provide “personal supercomputing” power for leading-edge development
**Legacy**

- Earth Simulator delivered the highest efficiency or high Bytes/Flops.
- Fairly easy to implement for harnessing full vector potential.
- Vectors are till today and for tomorrow will remain the ultimate super power for huge data processing of any super computing architecture.
- Yet reduction in size has been an area of improvement from legacy.

**Adapt/Evolve**

- Super computers unlike in the past, should now be available for everyone.
- Pure vectors needed for massive data processing but keeping in mind power and efficiency.
- Co-exist with others for solving problems.
- Continue the legacy....

**Change for Good**

- SX-Aurora TSUBASA (Wing) supercomputing processor on a PCIe Card and supporting heterogeneity.
- HBM2 and 1.2 TB/s of bandwidth with large vector pipes and cores delivering 2.15 TFLOPs DP per card.
- Auto-vectorization and parallelization for ease of programming.
- Continue the legacy to deliver High Bytes/FLOPs with power efficiency.
Wish to experience our NEC SX-Aurora TSUBASA?

Join our trial program today!

Contact Us: Info@hpc.jp.nec.com
Orchestrating a brighter world

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