

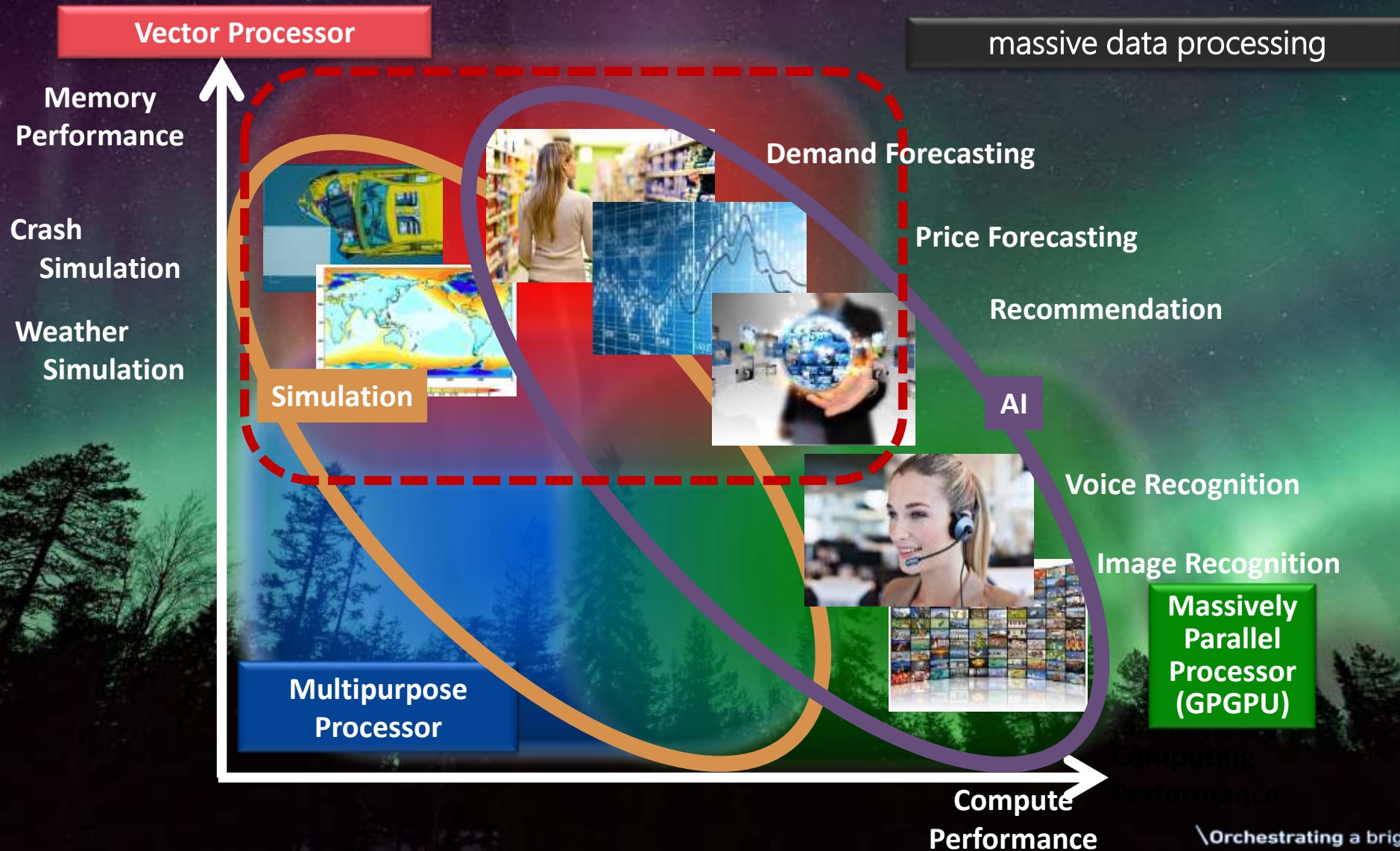
A vibrant aurora borealis (Northern Lights) display in shades of purple, blue, and green, set against a starry night sky. The aurora is reflected over a snowy, dark landscape with silhouettes of trees and hills.

# **SX-Aurora TSUBASA (Vector Engine)**

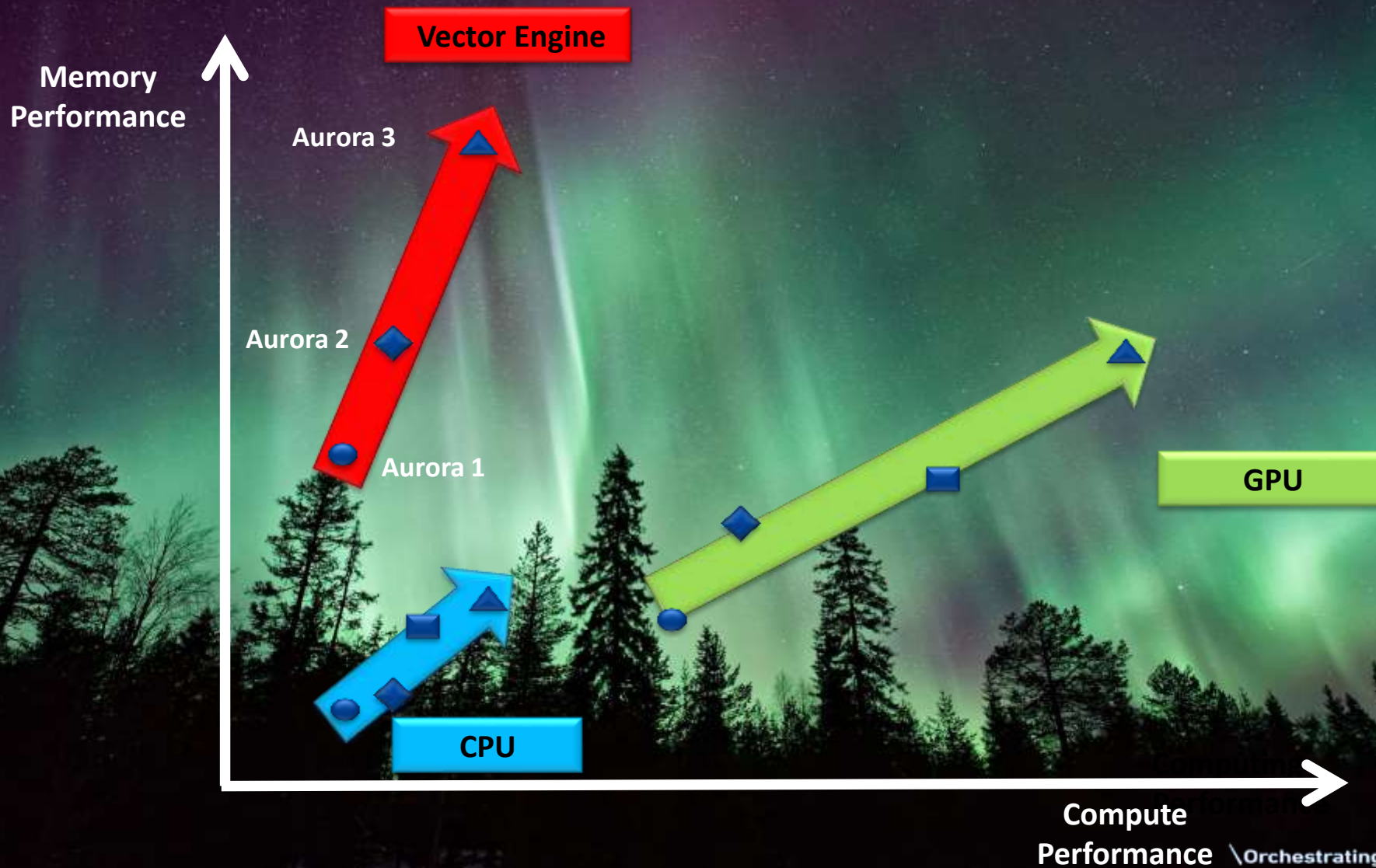
**Brand-new Vector Supercomputing power in Server Chassis**

**Deepak Pathania, OEM Alliance**

# High Bytes per FLOPs or Evolving towards massive data processing



# High Bytes per FLOP's Targeted Roadmap

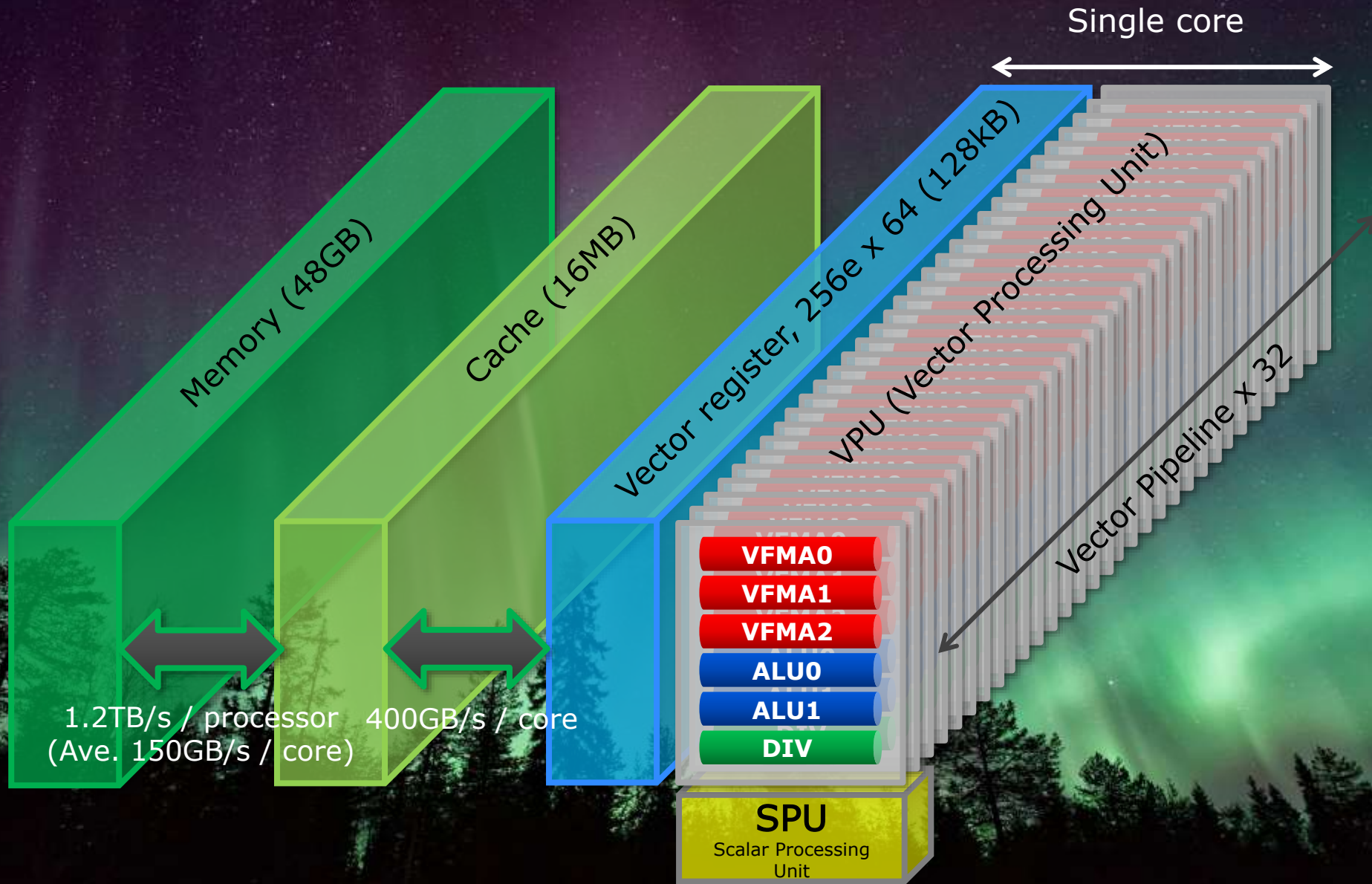


# Vector Processor on Card (World's Highest Memory Bandwidth Processor)



- 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



# Licensed

## C/C++ Compiler

- ISO/IEC 9899:2011 (aka C11)
- ISO/IEC 14882:2014 (aka C++14)

## Fortran Compiler

- ISO/IEC 1539-1:2004 (aka Fortran 2003)
- ISO/IEC 1539-1:2010 (aka Fortran 2008)

## 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

# Open-Source

## 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

# Ease of Programming

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

```
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);
    init_matrix(Ah, L, M);
    // do it again for matrix B
    alloc_matrix(&Bh, M, N);
    init_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;
}
```

No modification is necessary for vectorization

Just compile, and loops are vectorized automatically

### [Compiler diagnostic message]

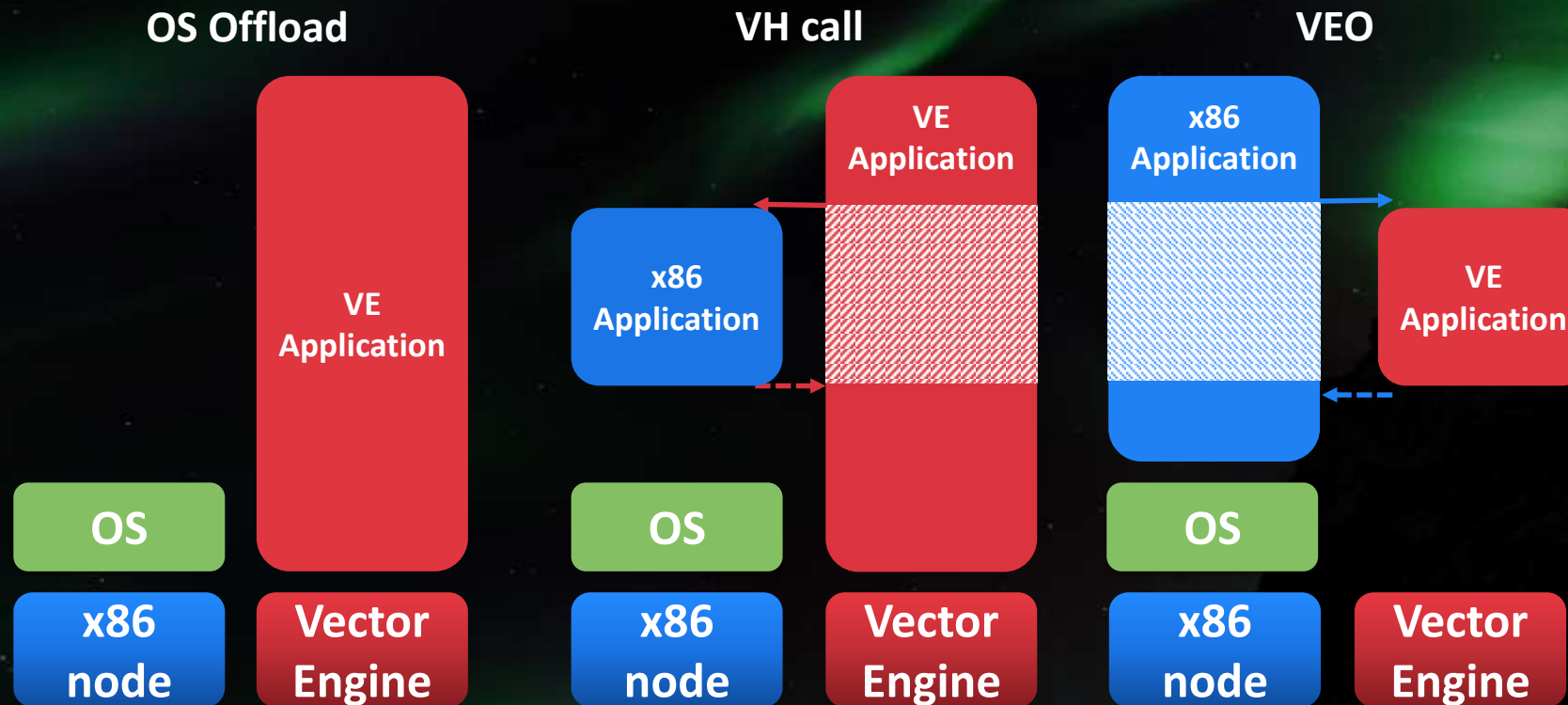
```
$ ncc sample.c -O4 -report-all -fdiag-vector=2
ncc: opt(1589): sample.c, line 11: Outer loop moved inside inner loop(s).: j
ncc: vec( 101): sample.c, line 11: Vectorized loop.
ncc: opt(1592): sample.c, line 13: Outer loop unrolled inside inner loop.: k
ncc: vec( 101): sample.c, line 13: Vectorized loop.
ncc: vec( 128): sample.c, line 14: Fused multiply-add operation applied.
ncc: vec( 101): sample.c, line 15: Vectorized loop.
```

### [Format list]

```
8:          void matmul(float *A, float *B, float *C, int l, int m, int n){
9:              int i, j, k;
10: +----->      for (i = 0; i < l; i++) {
11: |X----->      for (j = 0; j < n; j++) {
12: |V----->          float sum = 0.0;
13: |V-----F      for (k = 0; k < m; k++)
14: |              sum += A[i * m + k] * B[k * n + j];
15: |              C[i*n+j] = sum;
16: |X----->          }
17: +----->      }
18: }
```

# VEOS offload models

Run the application in the right way possible using VEOS



# 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

← **NEC**



**Hewlett Packard  
Enterprise** →



- ✓ #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.

A photograph of the Aurora Borealis (Northern Lights) in shades of green, dancing across a dark night sky. Below the lights, a dark, silhouetted mountain range is visible against a dark horizon. The foreground is a dark, flat landscape, possibly a tundra or plain, with some faint lights visible in the distance.

**Wish to experience our NEC SX-Aurora TSUBASA?**

**Join our trial program today!**

Contact Us: : [Info@hpc.jp.nec.com](mailto:Info@hpc.jp.nec.com)

 **Orchestrating** a brighter world

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