

Orchestrating a brighter world

**NEC**

# **SX-Aurora TSUBASA**

Passion for Sustained Performance

July 8<sup>th</sup> 2020 NEC Corporation

## SX-Aurora TSUBASA



POINT  
**1**

### Memory Bandwidth

1.53TB/s / processor, 150GB/s / core

POINT  
**2**

### Easy to Use

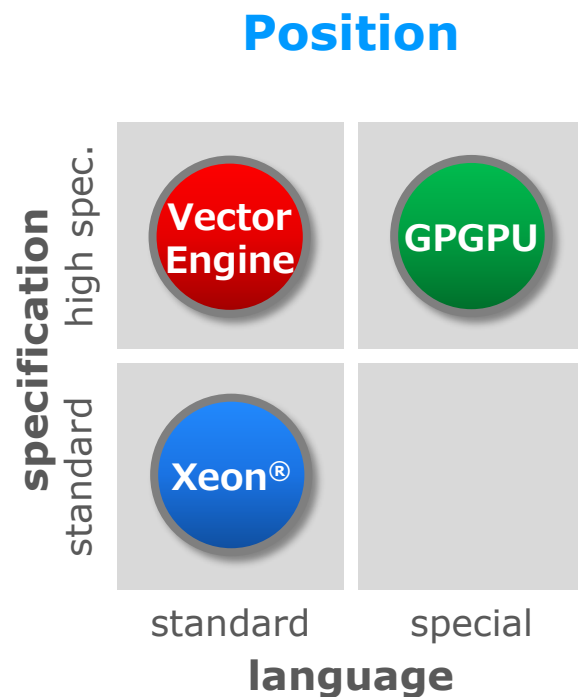
Fortran/C/C++ programming, OpenMP  
Automatic vectorization/parallelization

POINT  
**3**

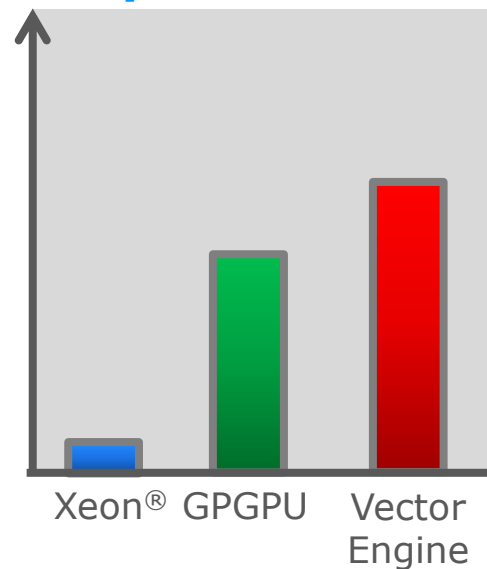
### x86/Linux

High sustained performance on  
x86/Linux environment

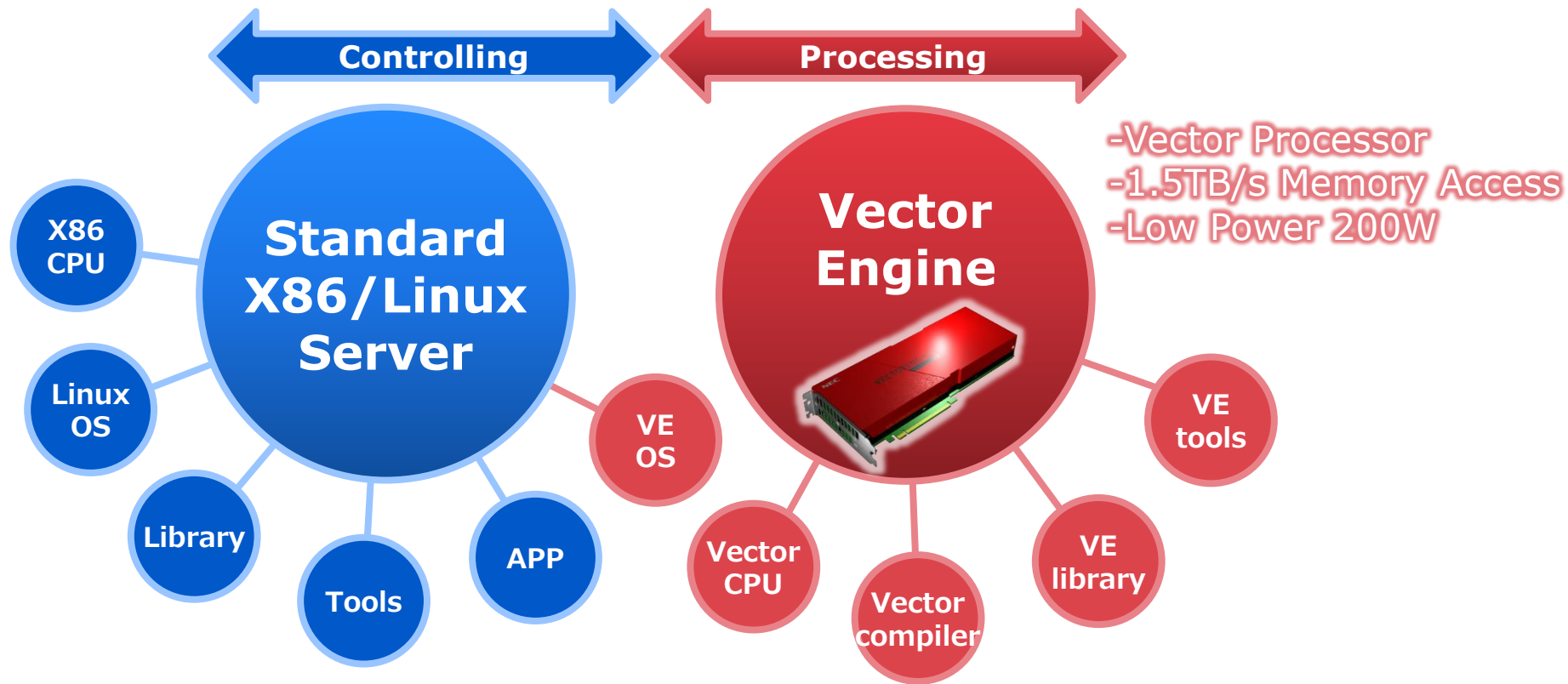
## Usability $\times$ High Memory Bandwidth



**Memory bandwidth / processor**

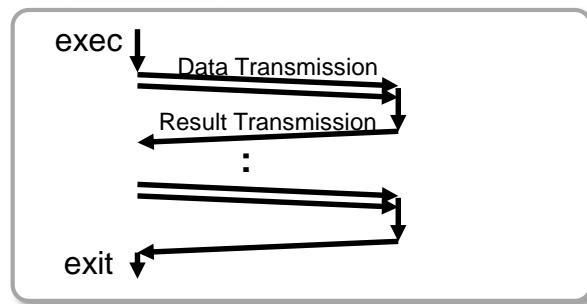
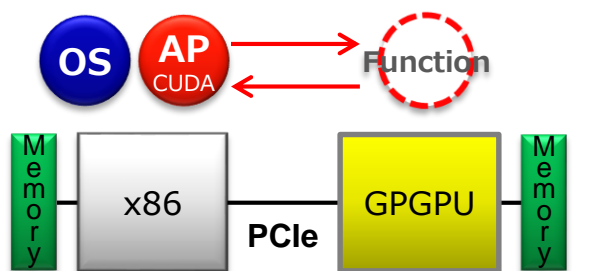


## SX-Aurora TSUBASA



# What is Different from GPGPU?

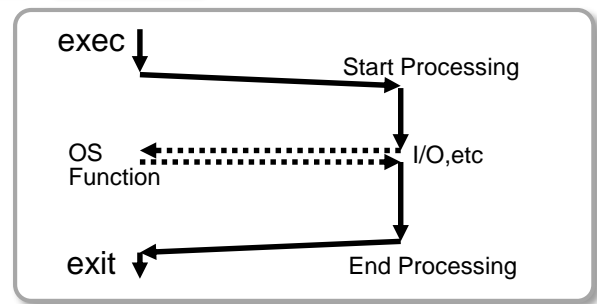
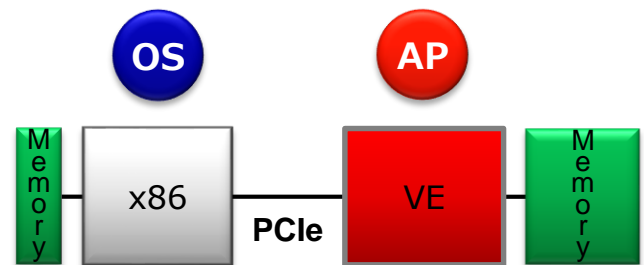
## GPGPU Architecture



**Frequent PCIe transmission**

- disadvantage**
- PCIe bottleneck
  - Small memory
  - Programming difficulty

## Aurora Architecture



**Whole AP is executed on VE**

- Advantage**
- Avoiding PCIe bottleneck
  - Larger memory
  - Standard language

## Programing Environment



```
$ vi sample.c  
$ ncc sample.c
```

### Vector Cross Compiler

automatic vectorization

automatic parallelization

Fortran: F2003, F2008(partially)

C: C11

C++: C++14

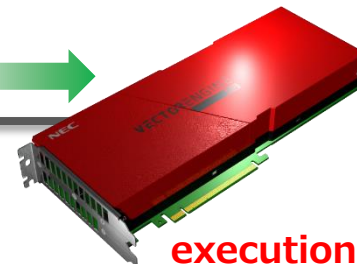
OpenMP: OpenMP4.5

MPI: MPI3.1

## Execution Environment



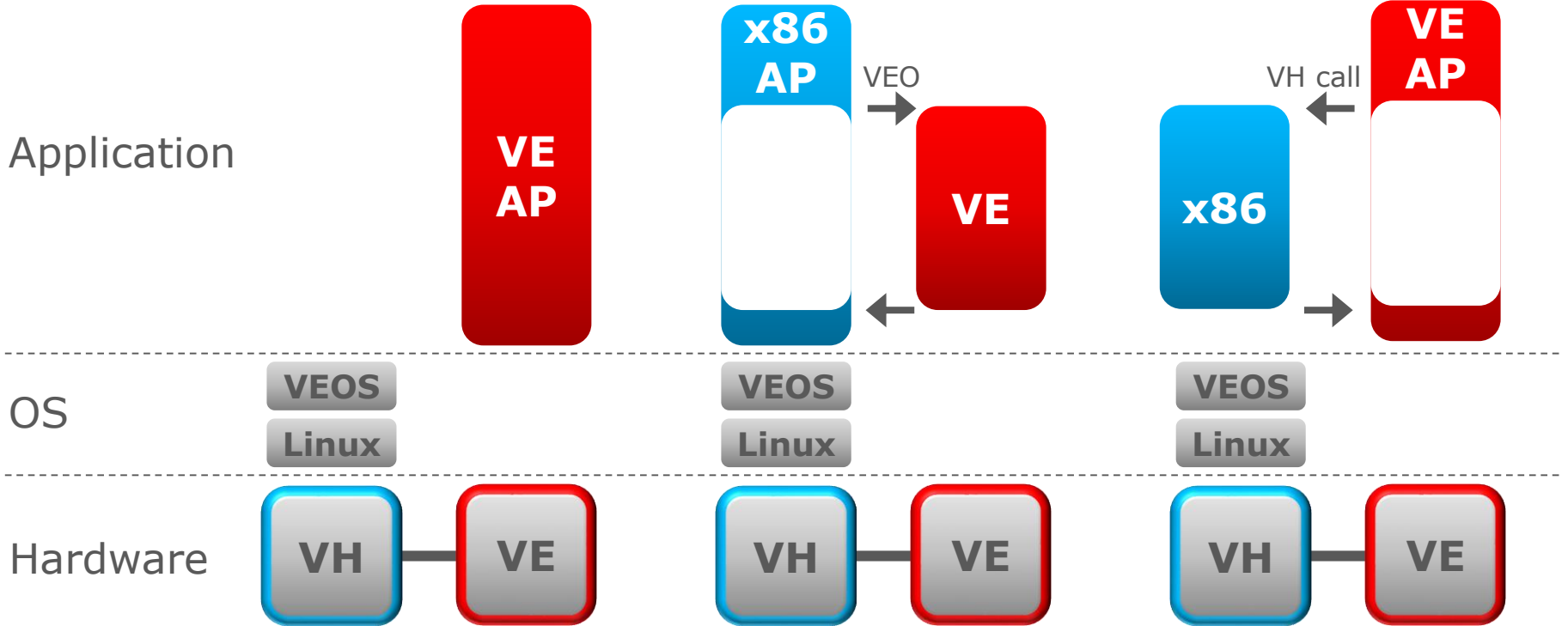
```
$ ve_exec a.out
```



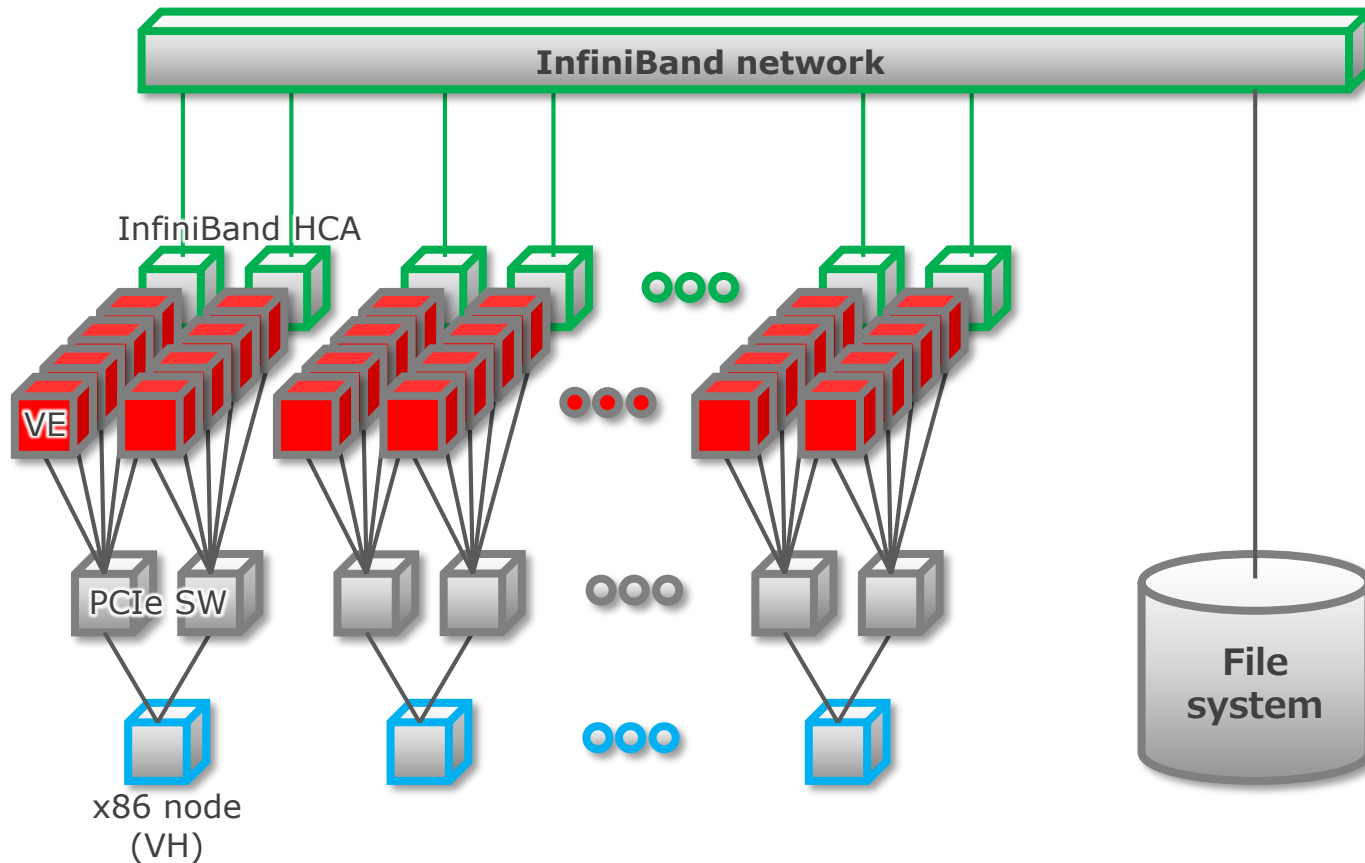
## Native Mode

## Accelerator Mode

## Scalar Acceleration Mode

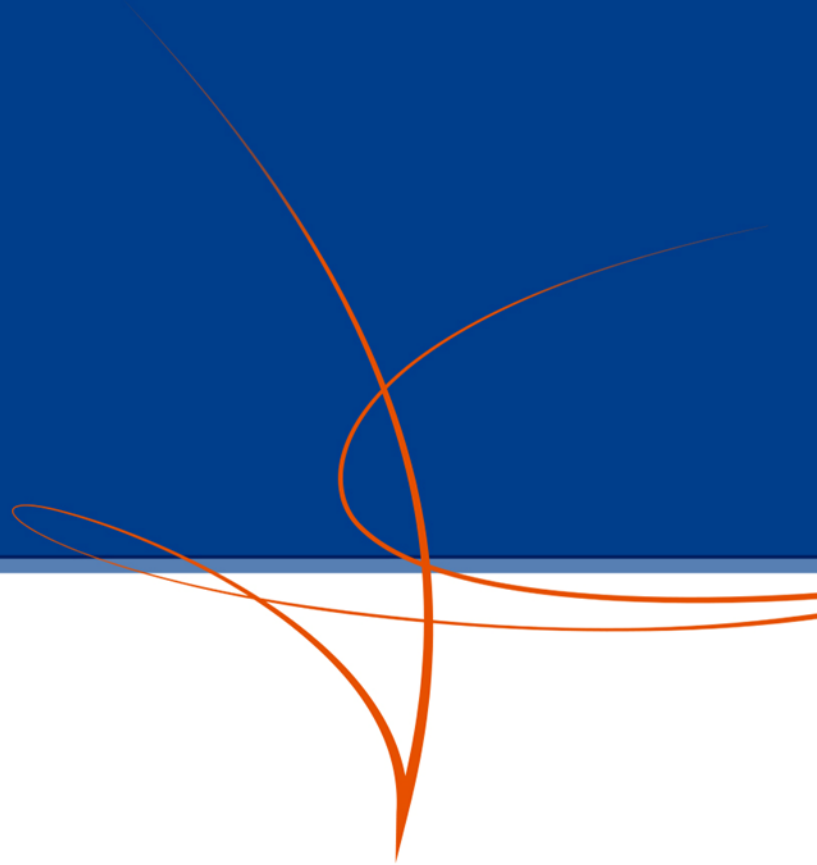


# Large System Configuration





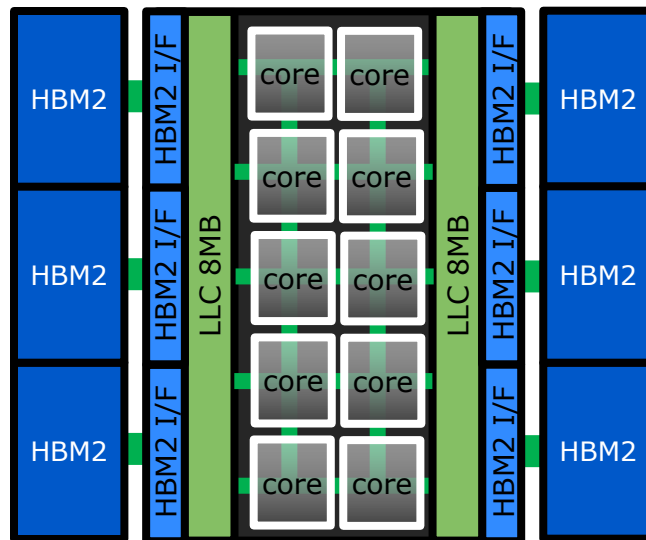
# Vector Engine



# VE20 Processor

## VE20 Specifications

Processor Version	Type A	Type B
Cores/processor	10	8
Core performance	307GF (DP) 614GF (SP)	
Processor performance	3.07TF (DP) 6.14TF (SP)	2.45TF (DP) 4.91TF (SP)
Cache capacity	16MB	
Cache bandwidth	3TB/s	
Cache Function	Software Controllable	
Memory capacity	48GB	
Memory bandwidth	1.53TB/s	
Power	~300W (TDP) ~200W (Application)	

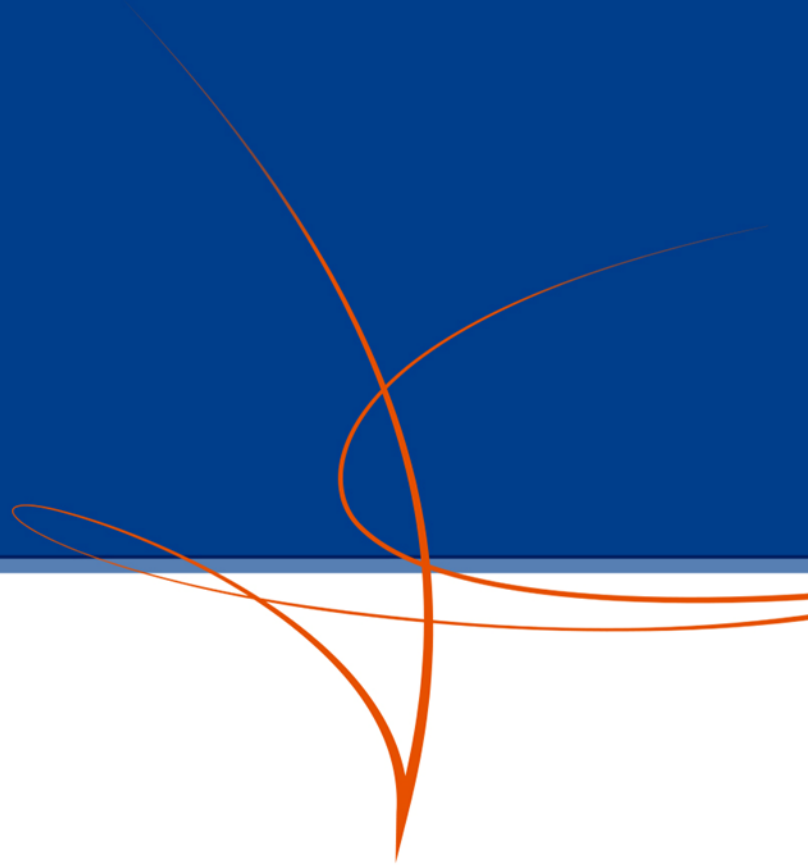


# Card Implementation

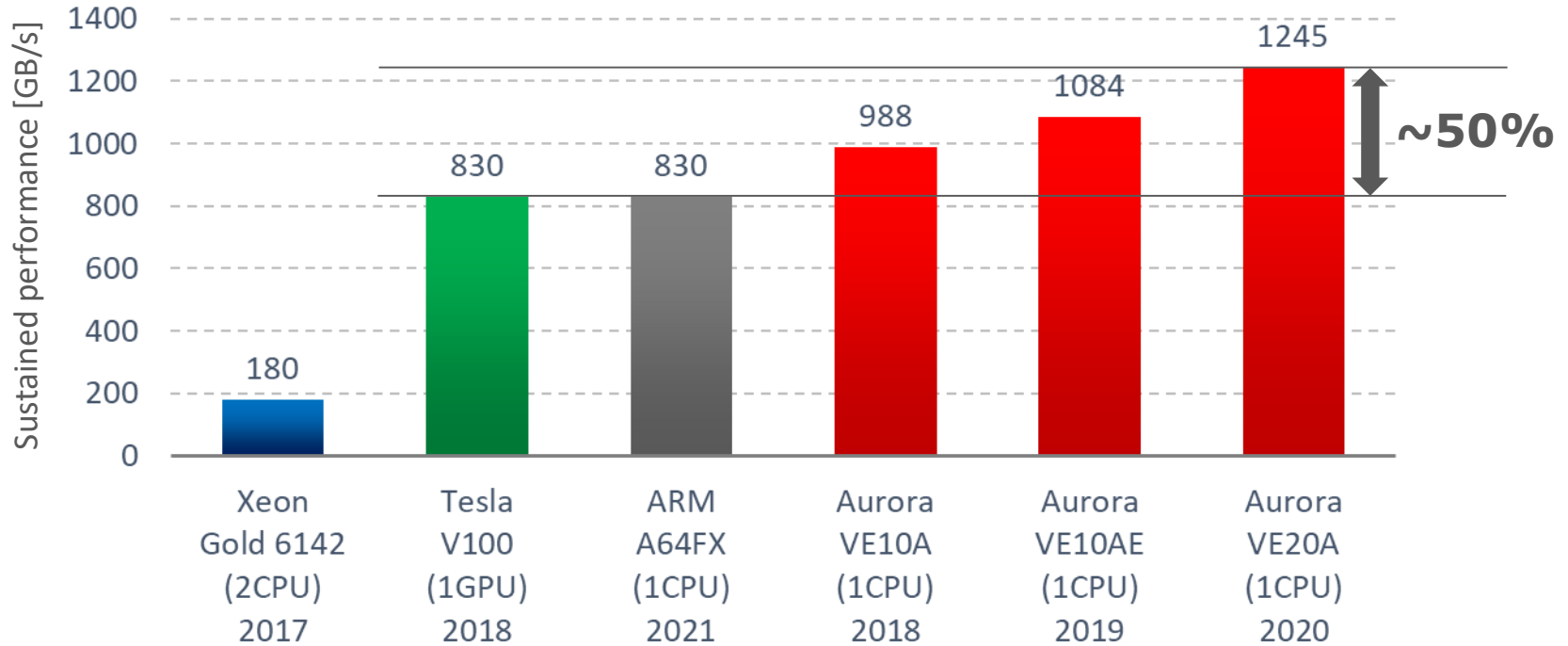


- Standard PCIe implementation
- Connector: PCIe Gen.3 x16
- Double height (same form factor as Nvidia)
- <300W (DEGEMM ~210W/VE, STREAM ~200W/VE, HPCG ~215W/VE)

# Performance



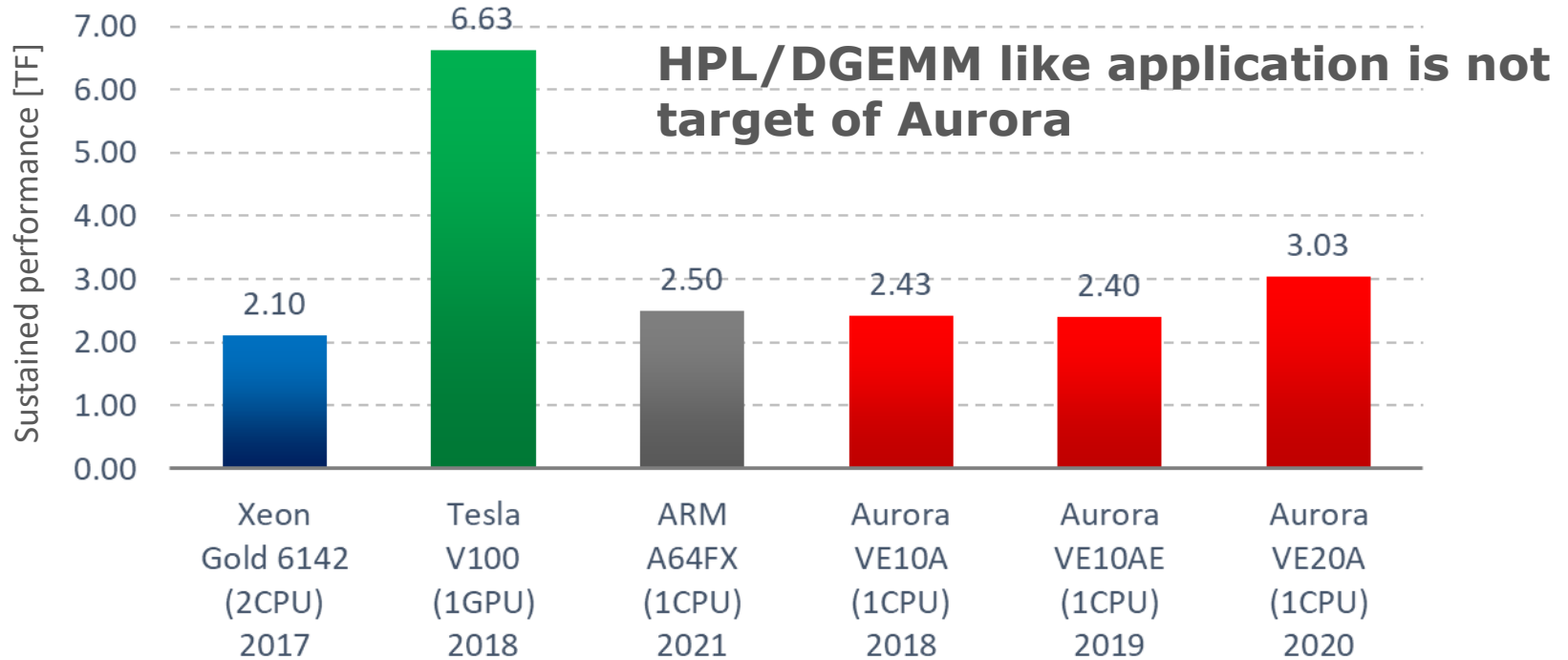
# STREAM TRIAD (Memory Bandwidth Evaluation)



ARM A64FX result: The post-K project and Fujitsu ARM-SVE enabled A64FX processor  
<https://indico.math.cnrs.fr/event/4705/attachments/2362/2942/CEA-RIKEN-school-19013.pdf>

**VE10A: 195W/card**

# DGEMM (Calculation Capability Evaluation)



V100 result: AMD NEXT HORIZON

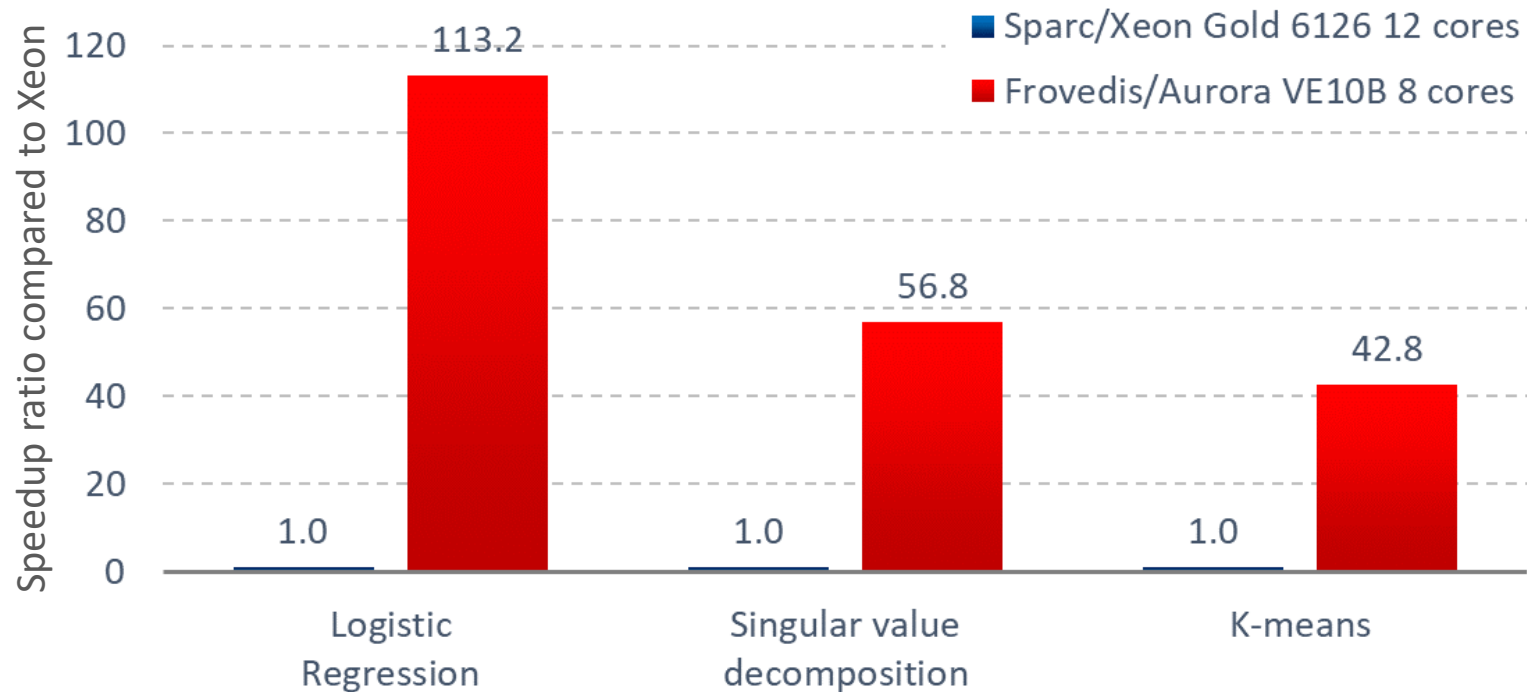
<http://ir.amd.com/static-files/ef99f84b-e1ad-4e12-8058-f3488f4c47b7>

ARM A64FX result: The post-K project and Fujitsu ARM-SVE enabled A64FX processor

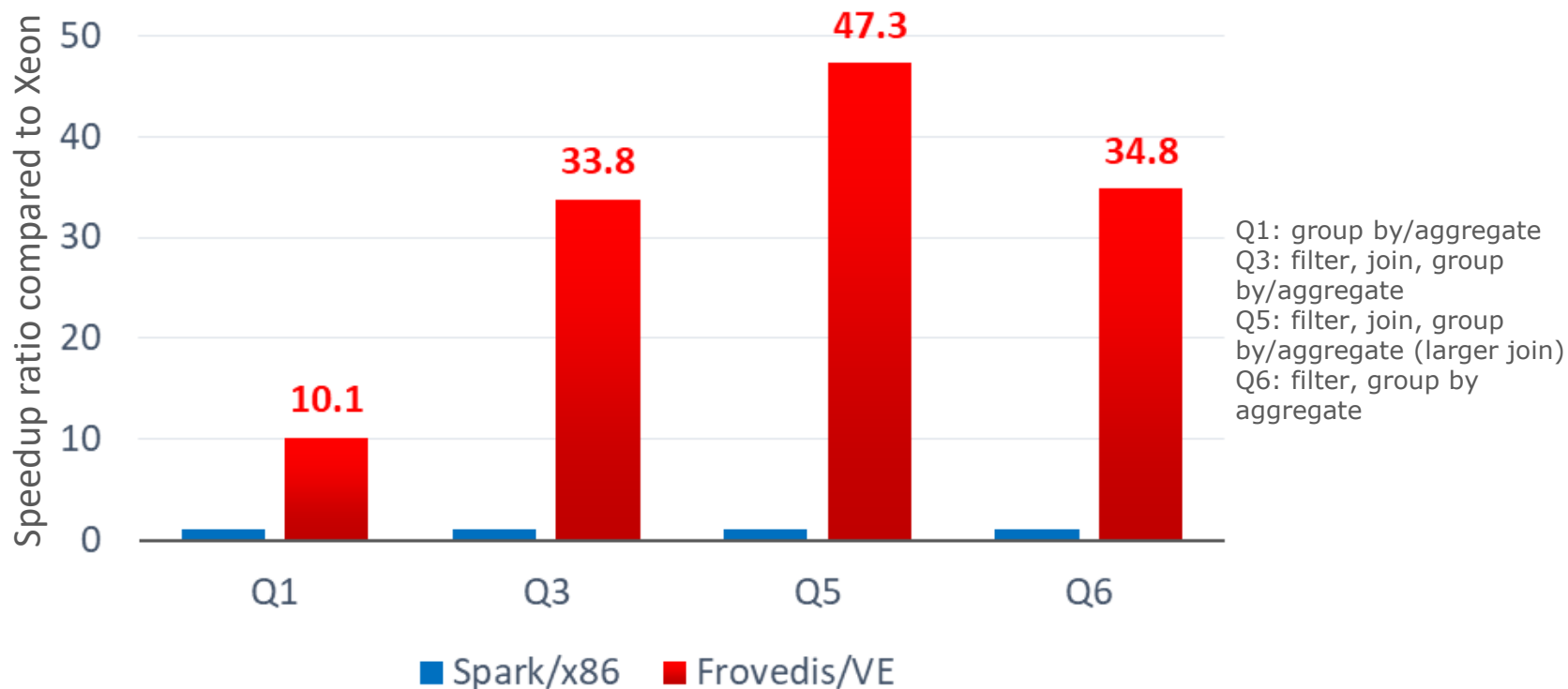
<https://indico.math.cnrs.fr/event/4705/attachments/2362/2942/CEA-RIKEN-school-19013.pdf>

**VE10A: 210W/card**

## Frovedis: NEC's Sparc library fully optimized for Aurora



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# Products

## X500 Supercomputer Model

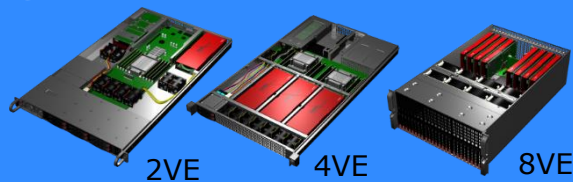
### X400

- For large scale configuration
- DLC with 40C water



## X300 Rack Mount Model

- Flexible configuration
- Air Cooled



## X100 Tower Model

- For developer/programmer
- Tower implementation



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