NEC User Group

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NEC's contribution to future HPC market

June 12th, 2024
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HPC Department, Infrastructure Technology Service Division,
Digital Platform Business Unit
／ Education and Science Solutions Department, Government and Public Solutions Division,
Public Solutions Business Unit
NEC Corporation

Agenda

1.NEC's HPC business policy and activities

Recent installations

CPU/GPU roadmaps

Scope for HPC and Data Utilization/ Data production

2. Characteristics of vector technology and future plan

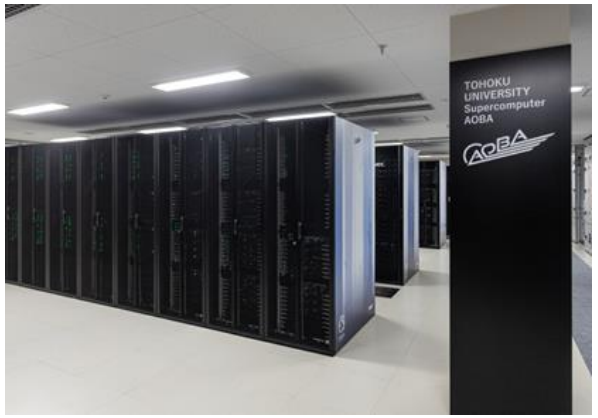
3. Summary

HPC Business Policy

In the Academic, Enterprise and Administration business domain,
We provide better HPC platforms, SI and services
to solve the social and business issues that
Scientific technology organizations and R&D organizations use for
large-scale scientific calculations effectively and efficiently.

Recent installations in Japan

Tohoku University “AOBA-S”

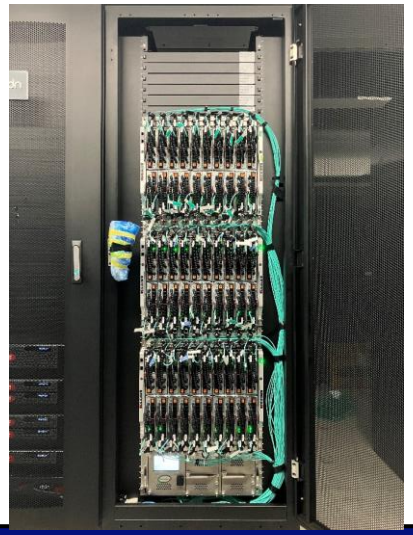


- **The World’s fastest vector computer** (21.05 PFLOPS)
- **504nodes of SX-Aurora TSUBASA new models**
- Computational performance 14x greater than existing system
- Top500 61th place, HPCG 13th place (June 2024)

University of Tsukuba “Pegasus”

- **Adopt H100 GPU and Sapphire Rapids, First in Japan** (Dec. 2022)
- **Green500** 20th place (June 2024), 41.12 GFLOPS/W, **Japan No.1**
- 120nodes of Intel Xeon Platinum 8468 (SPR) + NVIDIA H100 GPU (6.5 PFLOS)

Osaka University “handai-mdx”



- **Virtualization infrastructure used for various data utilization purposes**
- Red Hat OpenStack and VMware
- Coordinates with MDX system operating in University of Tokyo
- 60nodes of Intel Xeon Platinum 8480+ (SPR) x2

JAMSTEC “Earth Analyzer”

- **Virtualization infrastructure used for data analysis, publish, and disseminate**
- VMware vSphere and NSX (Firewall)
- 30nodes of Intel Xeon Gold 6430 (SPR) x2
- **Nodes and storage are connected with 100Gbps Ethernet (RoCE)**

Recent installations in EMEA

DWD

- **Phase 2b(adopt Aurora3) completed and started operation in 2nd half of 2023**
- Phase 3 contract ends 2023 installation Q4 2024
- Production of Milan Cluster Q2 2023
- **Additional system will be installed and start operation soon**

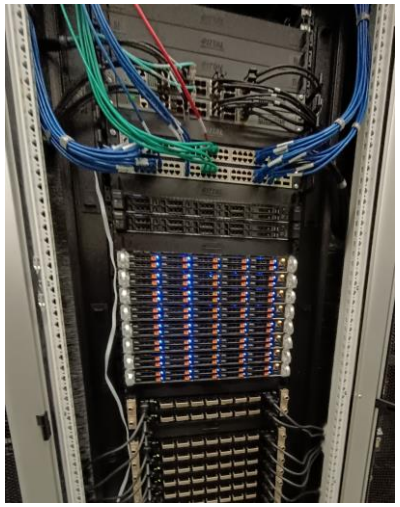
Universität Hamburg Hummel-2

- **178 CPU nodes with 2x AMD EPYC 9654 CPUs (Genoa)**
- 6 Huge Memory Nodes with 6TB RAM
- 4 GPU nodes with 8x NVIDIA H100 SXM
- **BeeGFS Storage 5PB usable**
- **Cornelis OPA Network**
- Direct water cooling

RWTH Aachen CLAIX-2023

- National HPC (NHR) System for Computational Engineering Science applications
- **632 nodes with 2x Intel Xeon Platinum 8468 CPUs(Sapphire Rapids)**
- 52 AI nodes with 4x NVIDIA H100 in a dedicated Machine-Learning partition
- Direct water cooling

Universität Tübingen



Expansion Level 1
- **5x GPU-Nodes with 8x NVIDIA H100**
- 4x Hypervisor-Systems

Expansion Level 2
- **10x GPU Nodes with 8x NVIDIA H100**
- 2x CPU Nodes with 2x AMD EPYC 9654
- 2x Hypervisor-Systems

Research information infrastructure enhanced from HPC

NEC will provide total solution of infrastructure such that generate, simulate, aggregate, utilize and manage Research Data.

Use by Academic institutes

・Promote data distribution in the academic community by collaborating with various services
・Enable data reference and sharing

DIAS, HPCIStorage, GakuninRDM

Create new social values

Publish

WWW

SINET

Use by Government and Companies

・Government can obtain data necessary for considering policies and services
・Companies use data and simulations for manufacturing and collaborating with academic institution

Research Information Infrastructure

Data Processing

Utilize

Virtualized Servers
GPU, Quantum

Data Storage

Object Storage
Archive Storage

Aggregate

HPC

Vector, Scalar
Parallel file system

Simulate

Generate

Data Management

RDM System

・Traceability
・ID/Metadata
・Share/Search
・Catalogue etc.

Manage

Reference control

Experiment Facility/Data

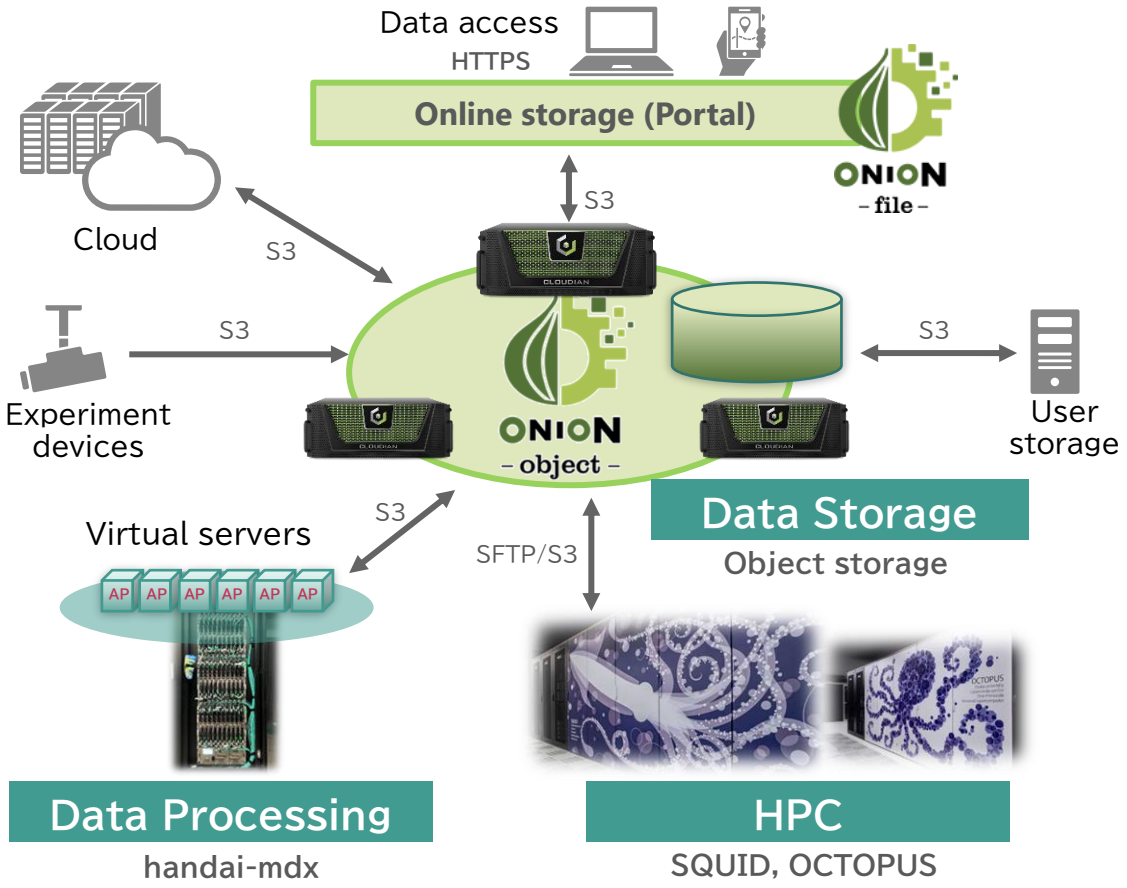
・Various Sensors
・Large experiment devices etc.

BluStellar
未来へ導く、光となる。

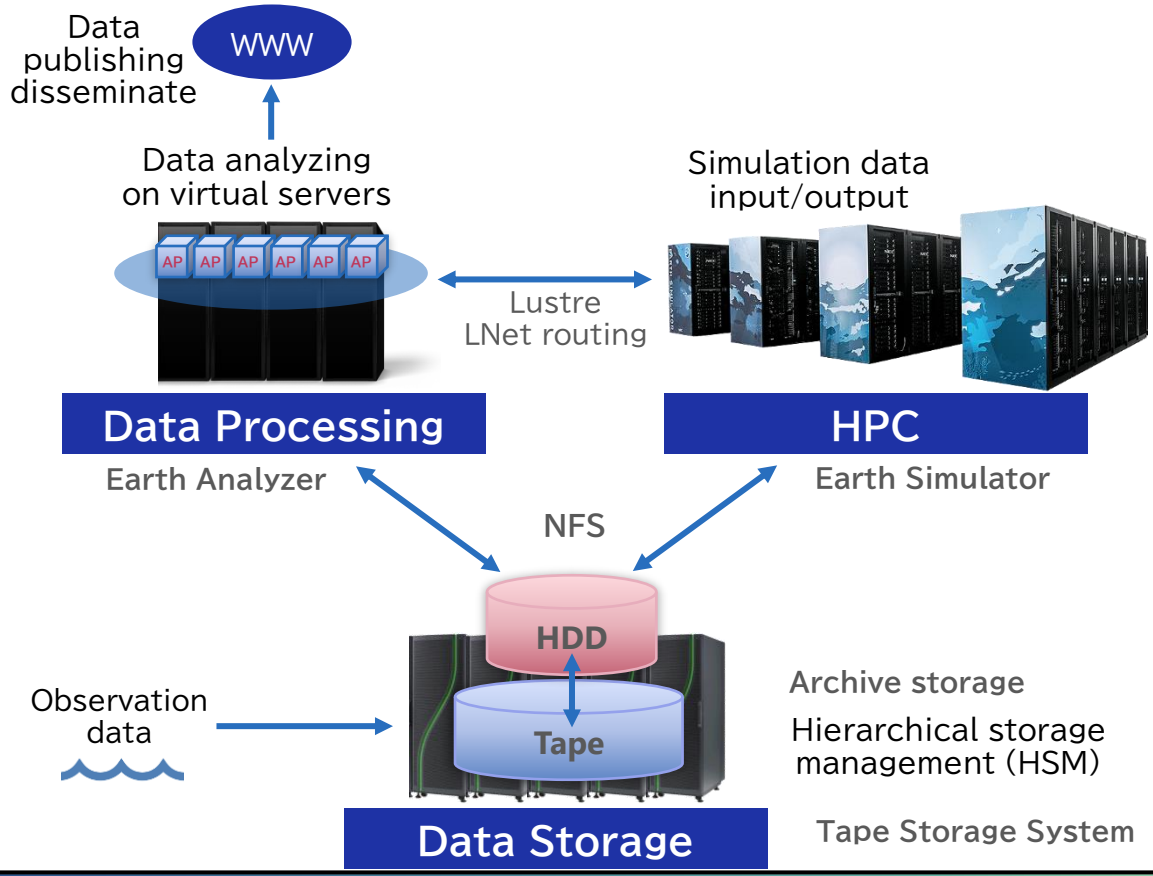
RDM :Research Data Management

Case Studies of Research Information Infrastructure

- Osaka University's data aggregation platform "ONION" combines with HPC "SQUID", data processing system "handai-mdx", public cloud, and several devices via S3 protocol.



- JAMSTEC has Earth Analyzer and Tape storage system in addition to HPC "Earth Simulator". Simulation data will be utilized using several applications, and efficiently archived with HSM.



Filesystem/storage

As research information infrastructure becomes increasingly important, file systems and storage will become even more critical.

IBM Storage Scale

- **Matured filesystem with reliability and rich functionality scope**
- Formerly known as GPFS

NEC SSE500
Storage Array

NEC HPC2112RK-1
Storage Server

LXFs / Lustre

- **For customers with IO intensive workloads**
- Used in a wide range of HPC environments.

NEC SNA 060i/120i
High-Density JBOD

NEC SSE400
Storage Array

BeeGFS

- **Good price / performance**
- Good for I/O intensive workloads

NEC SNA 060i/120i
High-Density JBOD

ddn

- **Good support (in Japan)**
- High-density, high performance
- Hybrid and full-flash storage solutions.

WEKA

- **Specialized for AI-Workloads**
- Optimized for NVMe.
- Tight S3 integration

NEC HPC2212RK-1
Storage Server

CLOUDIAN

- Cloud tiering
- Remote distribution

Characteristics of Vector technology and future plan

NEC long vector's technology competences (same process rule)

- ***NEC long vector's competence (vs CPU)***
  - ***Higher effective performance, Higher performance/power ratio***

- ***NEC Long vector's competences (vs GPU)***
  - ***Higher performance/power ratio under the memory intensive application***
  - ***Calculation accuracy of simulation results, therefore repeatable***

NEC long vector's technology competences (same process rule)

- **NEC long vector's competence (vs CPU)**
  - Higher effective performance, Higher performance/power ratio

When processing a large number of elements(vector, SIMD) simultaneously, long vector advantage delivers high performance

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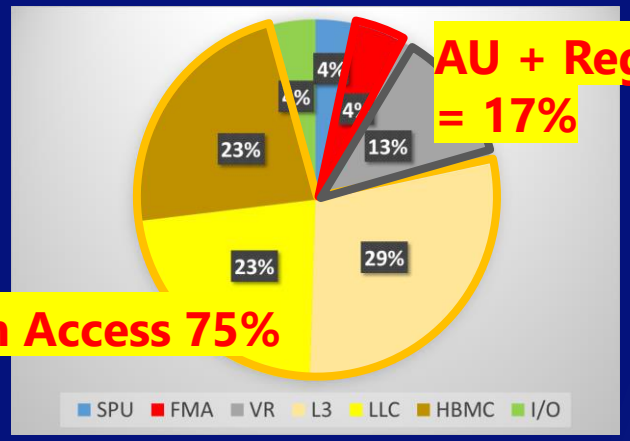
Architecture policy : Peak performance or Sustained performance with well balanced memory bandwidth

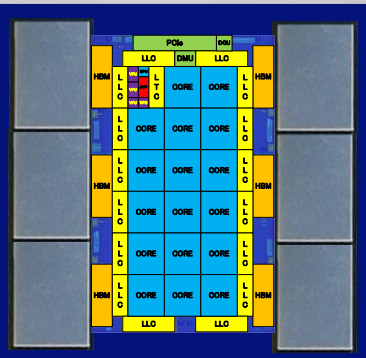
Footprint ratio comparison of Arithmetic Unit (AU) / Register / Memory Access on LSI

Vector Processor
SX-Aurora (4/13/75%)

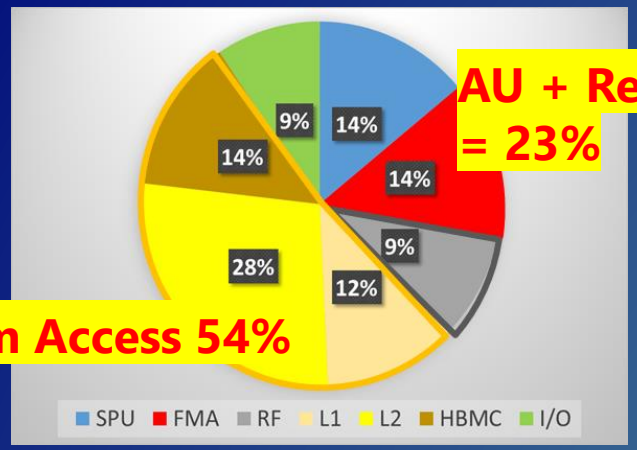


AU + Register = 17%

Mem Access 75%

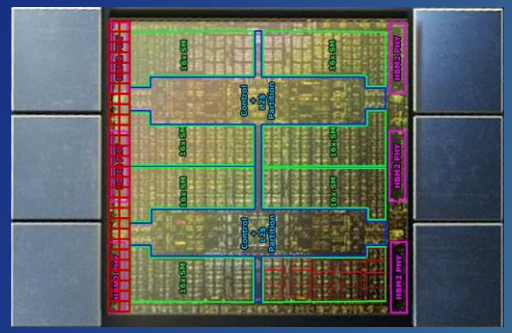


GPGPU
NVIDIA A100 (14/9/54%)

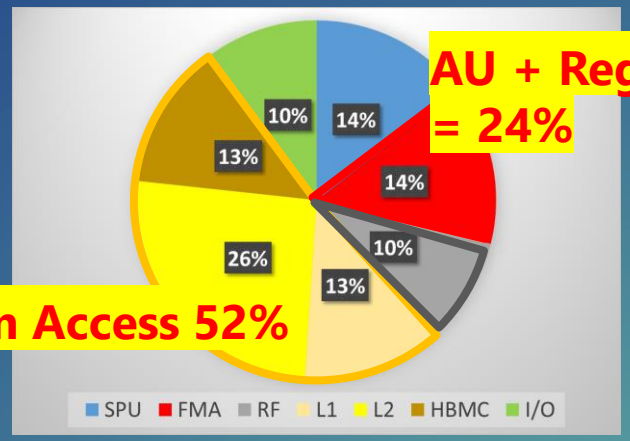


AU + Register = 23%

Mem Access 54%

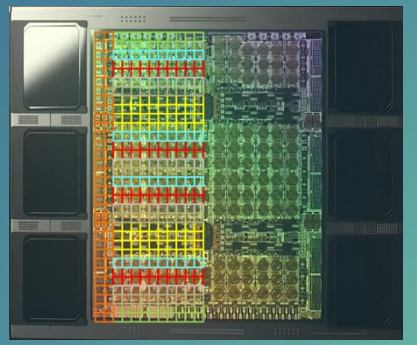


GPGPU
NVIDIA H100 (14/10/52%)



AU + Register = 24%

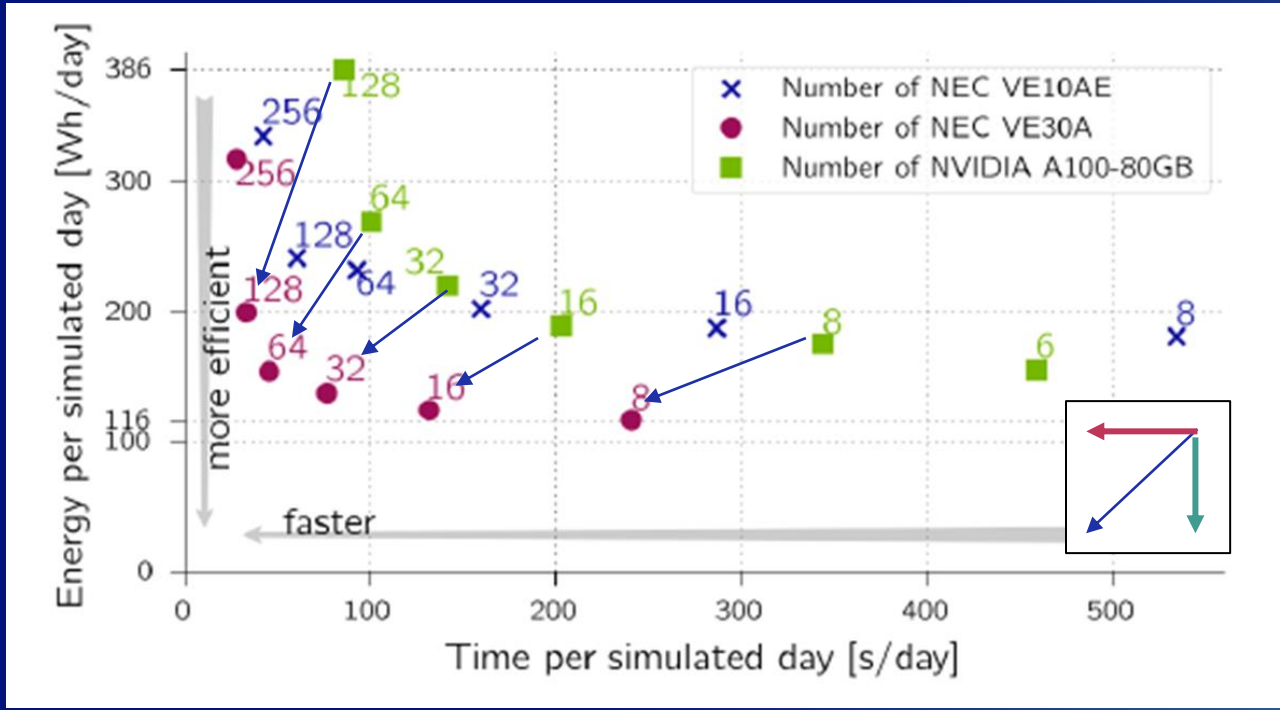
Mem Access 52%



Vector architecture is designed to better suite memory intensive applications

Calculation accuracy of simulation results

Vector is faster and more energy efficient



Performance and power consumption comparison using ICON (DWD NWP application)

VE30A : 7nm process rule
A100-80GB : 7nm process rule

Power consumption does not include CPU part

Panagiotis Adamidis, et al.
The Real Challenges for Climate and Weather Modeling on its Way to Sustained Exascale Performance : A Case Study using ICON (v2.6.6)
https://gmd.copernicus.org/preprints/gmd-2024-54/

VE30 is Faster and more energy efficient than A100

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Calculation accuracy of simulation results

Errors of Division / SQRT

Accelerator	Method	Error in Division	Error in SQRT
NEC Vector	Dedicated Arithmetic Unit	No Error	No Error
	Reciprocal Approximation (compiler code based)	No Error	With Error
GPGPU	Reciprocal Approximation (Function call)	With Error	With Error

No Error：IEEE754 compliant

Non-repeatability of results by Memory processing / Synchronization

Architecture	Memory processing	Synchronous processing	Result
NEC Vector	The order of memory write assured	Synchronizes computation among processor cores	Unique
GPGPU	The order of memory write in SM not assured	No synchronization among processor cores or SMs. (Much slower with an explicit sync option)	Not unique (Sum orders are not stable)

SM：Streaming Multi Processor

Vector Architecture Roadmap

Subject to change

performance

Next vector

VE30

16c/4.91TF,2.45TB/s memory bandwidth

VE20

10C/3.07TF, 1.53TB/s memory bandwidth

VE10E

8C/2.43TF, 1.35TB/s memory bandwidth

VE10

8C/2.45TF, 1.22TB/s memory bandwidth

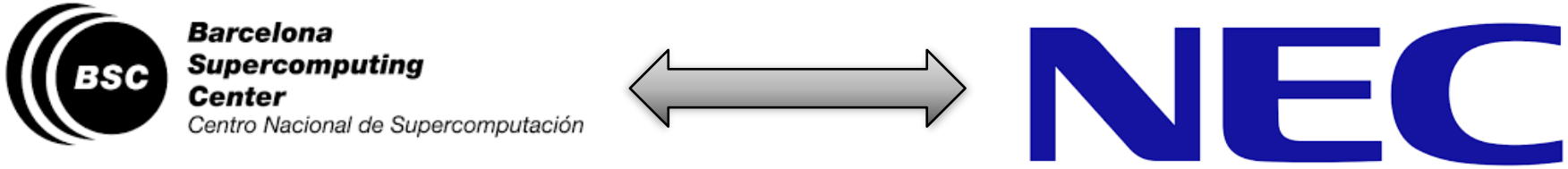
2019 2020 2021 2022 2023 2024 2025 2026 2027

- ***Barcelona Supercomputing Center(BSC) have researched Vector Accelerator.***
- ***Openchip Software Technologies (OCT) have plan to productize vector chip using BSC IP.***
- ***NEC wiil collaborate with their development with our IP and/or vector experiences.***

- ***Existing vector code would be able to run on this vector chip with minimum effort (porting and tuning)***
- ***NEC considers to provide server with next vector chip developed by OCT***

Discussion of collaboration for Vector Accelerator

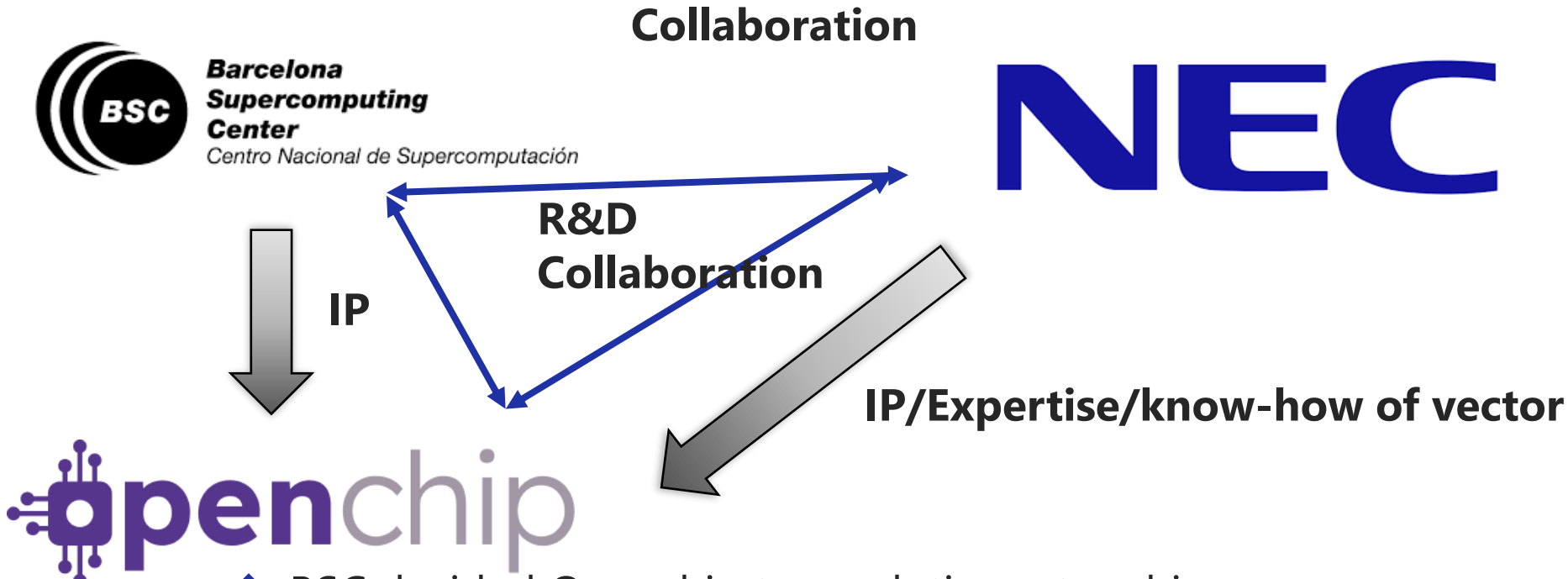
2023



- BSC and NEC are working together since last year.
- We were discussing how to collaborate for next vector chip.

Productization Scheme For Vector Accelerator

2024



- BSC decided Openchip to produtize vetor chips.
- NEC will make strong support to Openchip

Business Scheme For Vector Accelerator

2028～

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

NEC Customer

- Develop vector server
- System integration

NEC

Vector Accelerator (card)

openchip

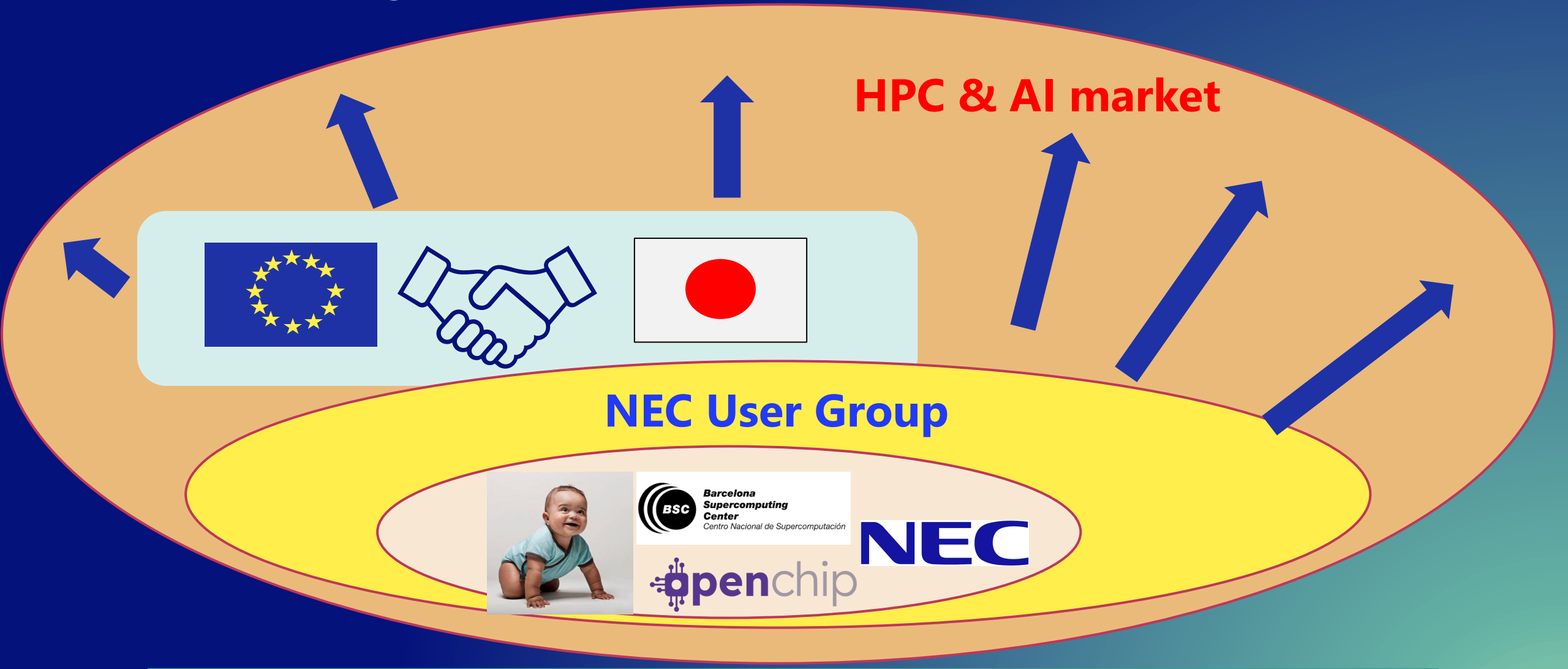
Video message from Prof. Mateo Valero (BSC)

- *BSC and NEC are working together since last June*
- *NEC has the best team in the world for vector architecture*
- *BSC created Openchip to deal with high performance vector architecture chip*
- *No doubt that we make very good vector chip*

Summary

- ***NEC will work on latest CPU and GPU solutions with collaboration between CPU/GPU vendors and NEC***
- ***NEC will provide total solution of Research information infrastructure such that generate, simulate, aggregate, utilize and manage Research Data.***
- ***NEC will continue delivering vector solution for accuracy, higher performance and higher energy efficiency under the collaboration between BSC/OCT and NEC***

Vector technologies will be continued



Your warm support for new vector accelerator will be appreciated

\Orchestrating a brighter world

NEC creates the social values of safety, security,
fairness and efficiency to promote a more sustainable world
where everyone has the chance to reach their full potential.