Introduction of mdx II , a new cloud infrastructure deployed at Osaka University

Cybermedia Center, Osaka University, Japan
Susumu Date

NUG2024 NEC User Group Meeting

Cybermedia Center, Osaka University

CMC main building

IT core as data center

- Supercomputing center at Osaka University
  - has a responsibility of providing a powerful high-performance computing environment for university researchers across Japan as a national joint-use facility.

Overview of Cyberinfrastructure at Cybermeia Center

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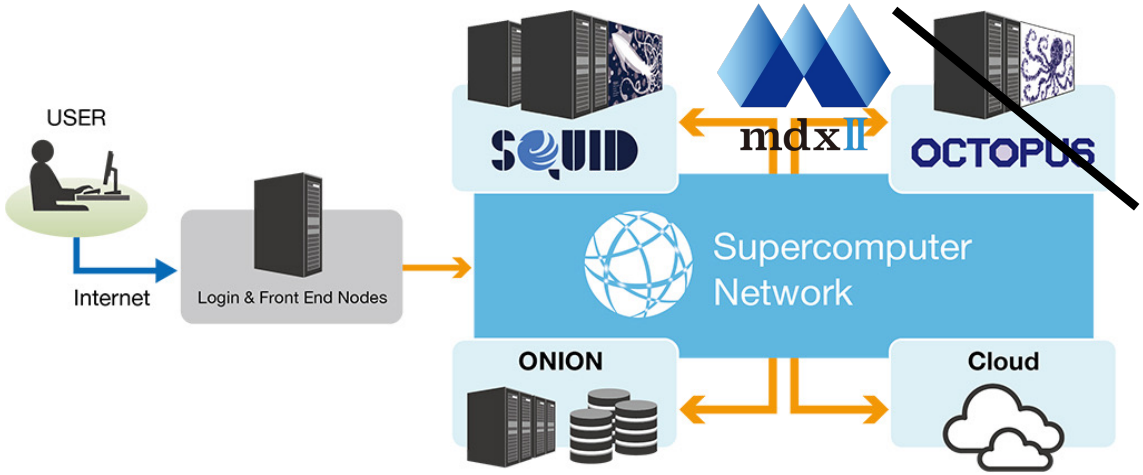
Open to researchers in Japan	Support diverse computing needs	Pflops-class compute capacity	Stable compute environment provision



- **Computing Infrastructure.**
  - ~~OCTOPUS: 1.4 Pflops Since 2017~~
  - SQUID : 16.594 Pflops since 2022
  - mdx II : 0.4 Pflops since 2024
- **Data Aggregation Infrastructure**
  - **ONION**
    - Object Storage HyperStore (0.5 PB)
    - Parallel File System ExaScaler (21PB)

POINT

Two supercomputing systems are available on data aggregation infrastructure.

Two supercomputing systems guarantee the sustainability of computing infrastructure and data infrastructure. Also, ONION facilitates researchers to share scientific data with researchers in the world.

OCTOPUS since Dec. 2017

OCTOPUS
Osaka university Cybermedia cenTer
Over-Petascale Universal Supercomputer

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Osaka University

- **PetaFlops-class Hybrid Supercomputing Systems**

(Osaka university Cybermedia cenTer Over-Petascale Universal Supercomputer)

- **Theoretical (peak) Performance 1.463 PFlops**

We are in the process of procurement for next OCTOPUS. (Target: September 2025)

OCTOPUS 1.46 PFlops

CPU nodes: 236	
プロセッサ	Intel Xeon Gold 6126 (Skylake / 2.6 GHz 12コア) 2基
主記憶容量	192 GB
インターコネクト	InfiniBand EDR (100 Gbps)
GPU nodes: 37	
プロセッサ	Intel Xeon Gold 6126 (Skylake / 2.6 GHz 12コア) 2基
主記憶容量	192 GB
アクセラレータ	NVIDIA Tesla P100 (NVLink) 4基
インターコネクト	InfiniBand EDR (100 Gbps)
Many core nodes: 44	
プロセッサ	Intel Xeon Phi 7210 (Knights Landing / 1.3 GHz 64コア) 1基
主記憶容量	192 GB
インターコネクト	InfiniBand EDR (100 Gbps)
Large memory nodes: 2	
プロセッサ	Intel Xeon Platinum 8153 (Skylake / 2.0 GHz 16コア) 8基
主記憶容量	6 TB
インターコネクト	InfiniBand EDR (100 Gbps)
Storage	
ファイルシステム	DDN EXAScaler
容量	3.1 PB

SQUID since May 2021

Supercomputer for Quest to Unsolved Interdisciplinary Datascience

Cybermedia Center Osaka University

- **Cloud-linked High Performance Computing and High Performance Data Analysis Supercomputer System (Supercomputer for Quest to Unsolved Interdisciplinary Datascience)**
  - **Peak Performance 16.591 PFlops**

SQUID システム構成

CPU nodes

1520 nodes x peak perf. 5.837 TFlops 8.871 PFLOPS

プロセッサ	Intel Xeon Platinum 8368 (Ice Lake / 2.40 GHz 38コア) 2 基
主記憶容量	256 GB

GPU nodes

42 nodes x peak perf. 161.836 TFlops 6.797 PFLOPS

プロセッサ	Intel Xeon Platinum 8368 (Ice Lake / 2.40 GHz 38 コア) 2 基
主記憶容量	512 GB
GPU	NVIDIA HGX A100 8 GPU ボード (Delta)

Vector nodes

36 nodes x peak perf. 25.611 TFlops 0.922 PFLOPS

プロセッサ	AMD EPYC 7402P (2.8 GHz 24コア) 1 基
主記憶容量	128 GB
Vector Engine	NEC SX-Aurora TSUBASA Type 20A 8 基

Interconnect

ノード間接続	Mellanox InfiniBand HDR (200 Gbps)

ONION data aggregation Infra.

S3-compatible Parallel File System 21.2PB

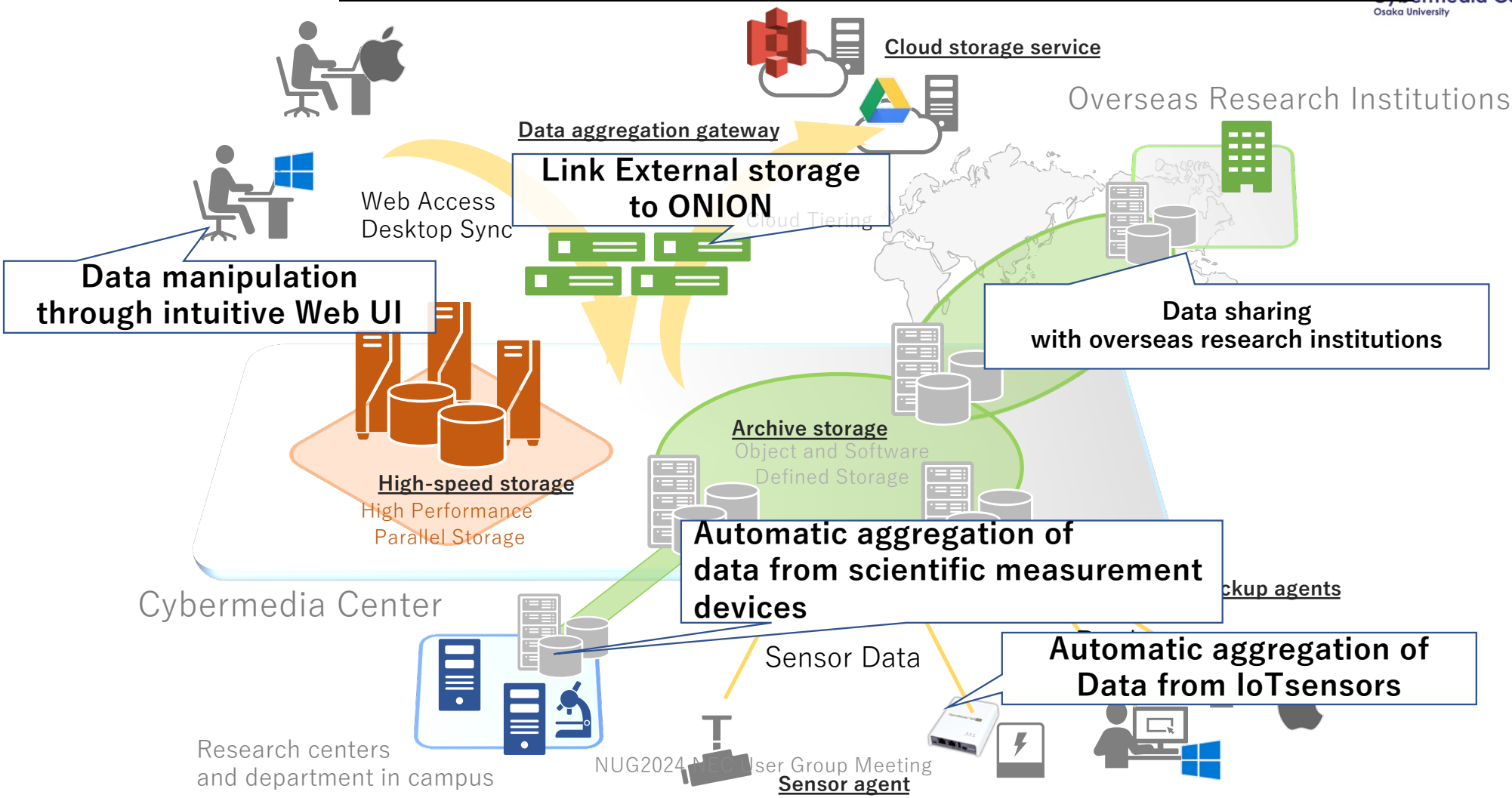
ファイルシステム	DDN EXAScaler (Lustre)
HDD	20.0 PB
SSD	1.2 PB

S3-compatible Object Storage 500TB

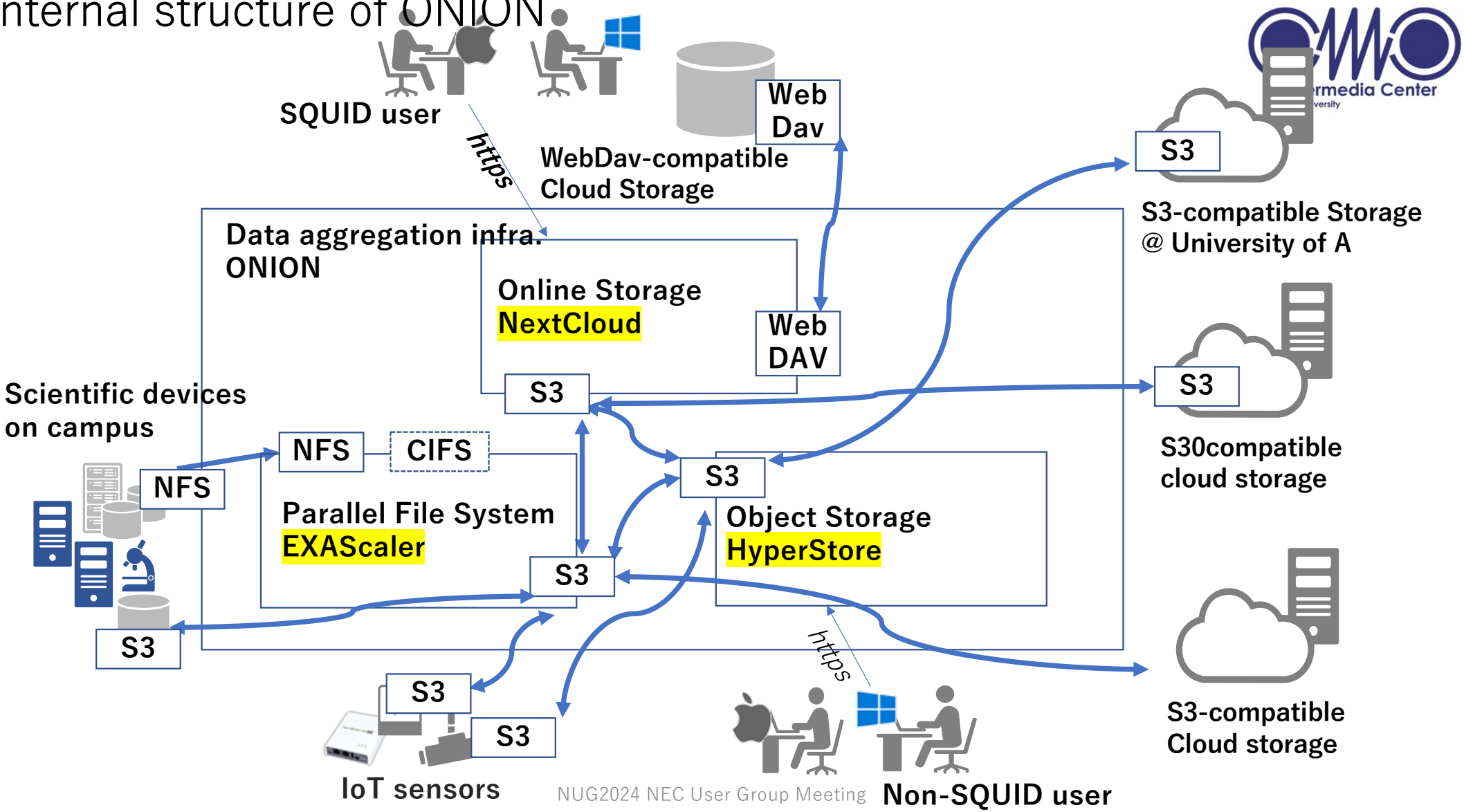
オブジェクトストレージ	CLOUDIAN HyperStore
HDD	500 TB

Overview of ONION

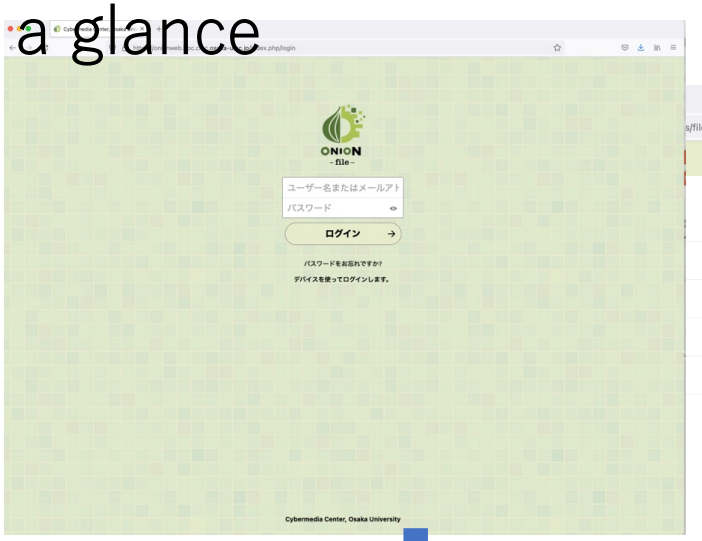
3 storage solutions are seamlessly combined in a synergic manner

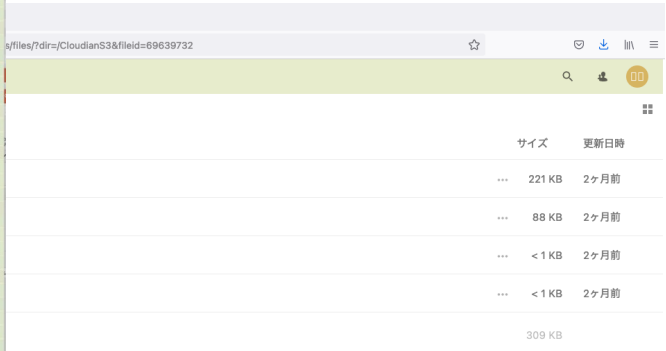


Internal structure of ONION



ONION at a glance





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DDN EXAScaler

Cloudian HyperStore Appliance 1610

Labo. webdav

Reserch institute S3

Scientific devices

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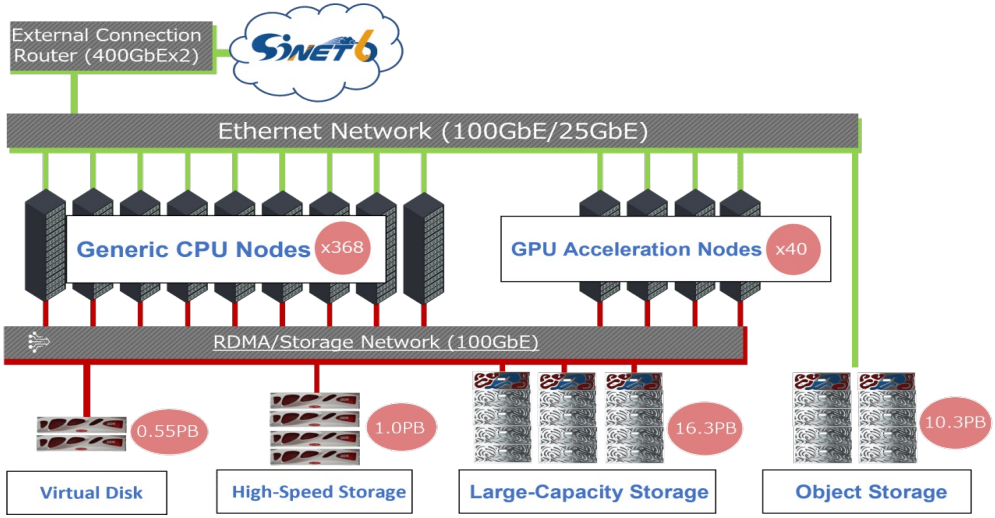
Background of mdx II

[Background of mdx II] A Cloud Platform for Supporting Data Science and Cross-Disciplinary Research Collaborations (mdx)

- mdx system was installed at University of Tokyo in 2021.
- It is a vmware-based IaaS-typed cloud infrastructure
- The mission of mdx is to enable academia (universities and national research institutions), industry, and government to collaborate rapidly, closely and efficiently by sharing knowledge of data and information sciences, knowledge and culture in specific fields, data and software, and **a computational infrastructure** that runs the necessary software
- 9 universities and 2 research institutes have been jointly operating mdx



mdx is virtualized with VMware and sliced per unit in vCPU and GPU.

Hokkaido University
Information Initiative Center

Tohoku University
Cyberscience Center

Center for Artificial Intelligence Research
University of Tsukuba

Information Technology Center
The University of Tokyo

National Institute of Informatics

National Institute of Advanced Industrial Science and Technology
Information Technology and Human Factors

Tokyo Institute of Technology Global Scientific Information and Computing Center

Nagoya University Information Technology Center

Academic Center for Computing and Media Studies,
Kyoto University

Cybermedia Center
Osaka University

Research Institute for Information Technology
Kyushu University

https://mdx.jp/

A Cloud Platform for Supporting Data Science and Cross-Disciplinary Research Collaborations（mdx)

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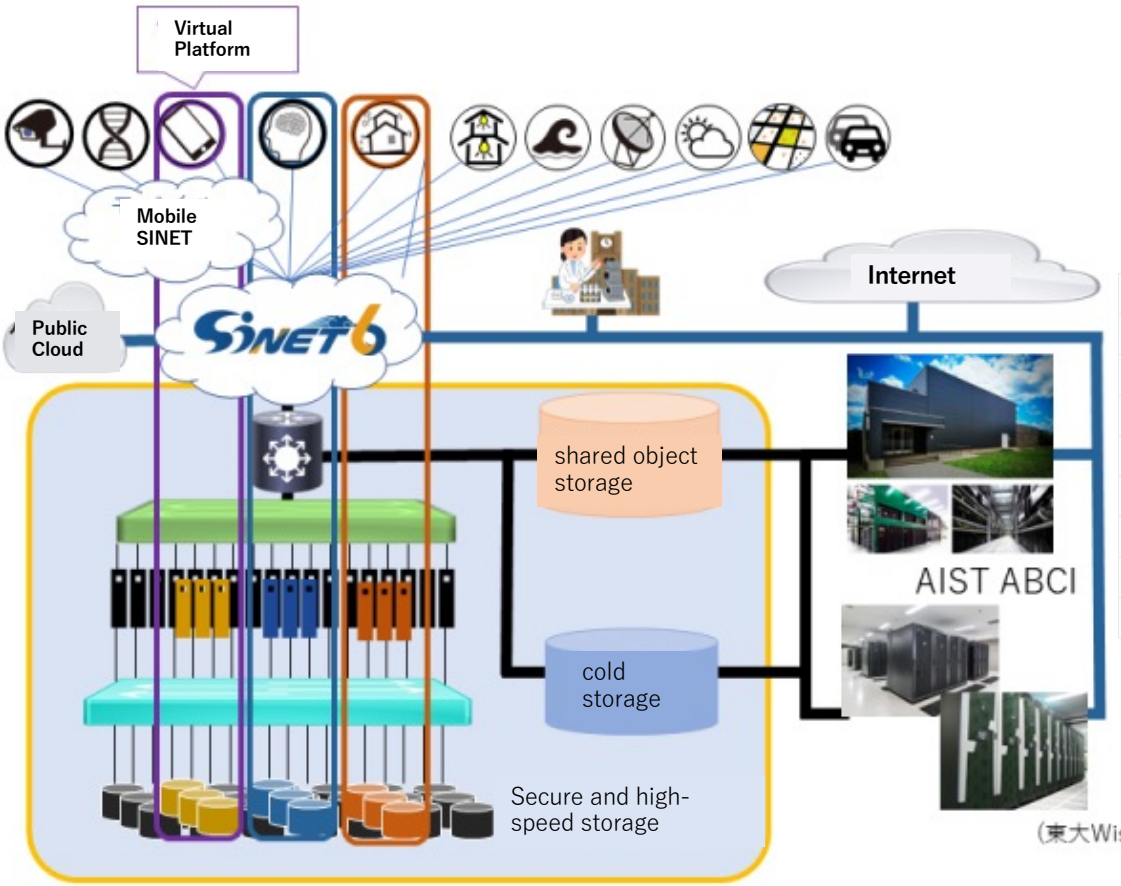
Osaka University



The mdx system allows users to build their own software stack (virtual machine) by slicing computational, storage and network resources per unit in vCPU and GPU,

	CPU Pack	GPU Pack
CPU Cores	1 Virtual Core	18 Virtual Cores
GPUs		1 GPU
Memory	1.51GB	57.60GB
GPU Memory		40GB
Maximum # Packs Assignable to 1 Virtual Machine	152 Packs	8 Packs
Total Theoretical Computational Performance (Double Precision)	Approx. 38.35 GFLOPS	Approx. 20.2 TFLOPS
Total Theoretical Computational Performance (Single Precision)		Approx. 20.9 TFLOPS
Total Theoretical Computational Performance (Half Precision)		Approx. 315 TFLOPS

https://mdx.jp/

[Long road to mdxII]　mdx platform is getting old.

- University of Tokyo (as mdx organization) appealed the necessity and importance of mdx II for supporting Japanese researchers in a sustainable way to MEXT (the Ministry of Education, Culture, Sports, Science and Technology, Japan)

  (36億円: 21,332,539.54 EURO)

- mdxII proposal was approved, but the budget was 5億円(2,962,581.89 EURO) as a supplementary budget in 2022…

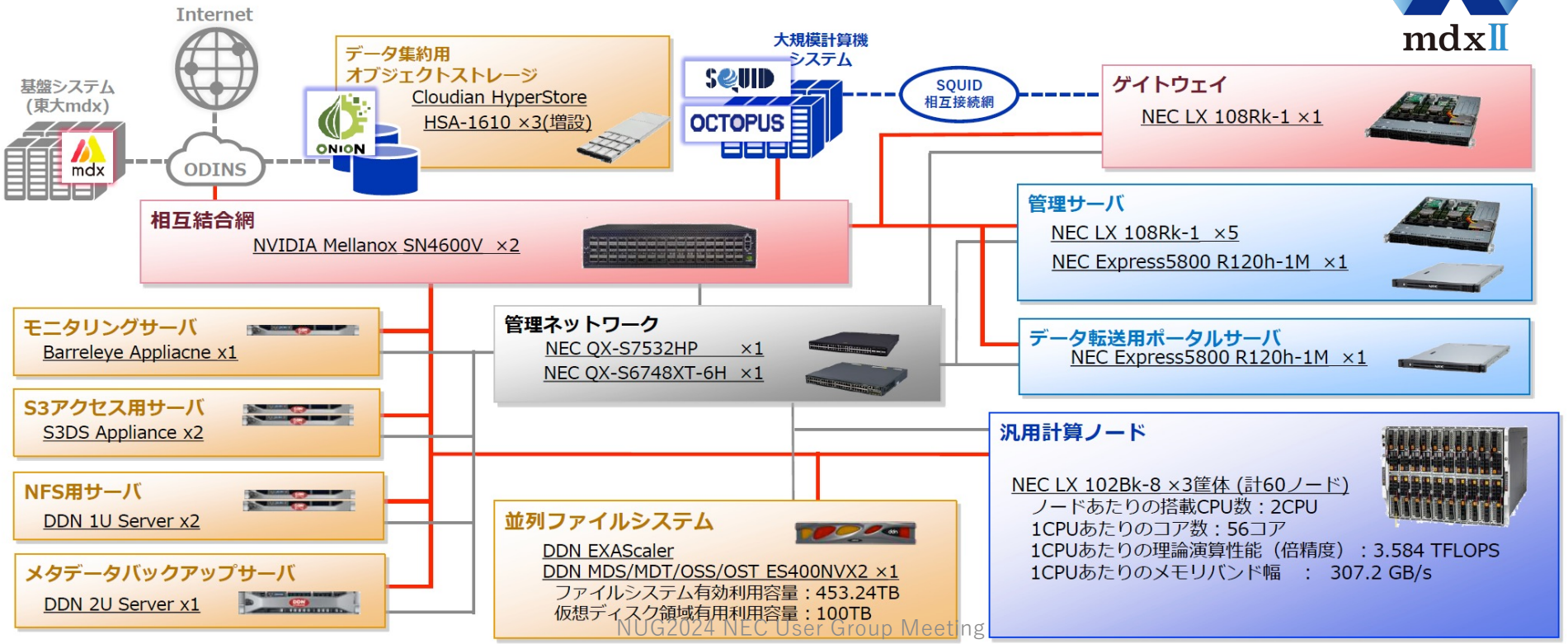
  (We have been requesting the expansion of mdx2… As the result, another approx. 5億円 was accepted in 2023 and we are now working for the procurement of mdxII. Also I have just submitted the further expansion proposal of mdxII last month in 2024 for next fiscal year…)

- From the aspects of resilience to disasters, Osaka University became a candidate location to install mdx II system.

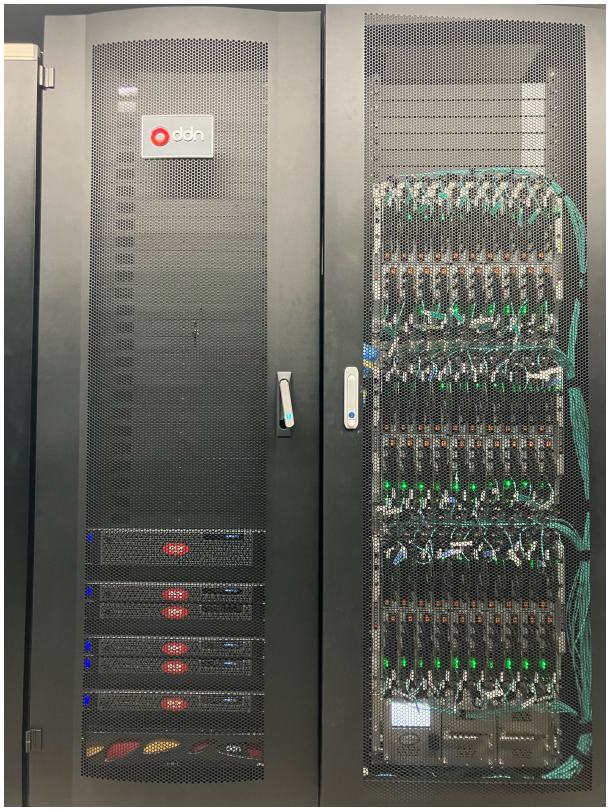
- We investigated the feasibility of installing the system at Osaka University from the following major perspectives.
  - Whether power and cooling facility has enough capacity to accommodate it? Even if possible, whether it affects to the future system installation planning at our center?
  - Whether the running cost after installing the system can be financially covered?
  - How many engineers are required for stable operation?
  - What is the merit of accepting the system for Osaka University?

Overview of mdx II

- IaaS (Infrastructure-as-a-Service) –typed Computing infrastructure
  - NEC LX 102Bk-8 (Intel Sapphire Rapids 56core x 2) x 60 nodes
  - Using OpenStack, Vmware –based virtualization.



Specsheet of mdx II

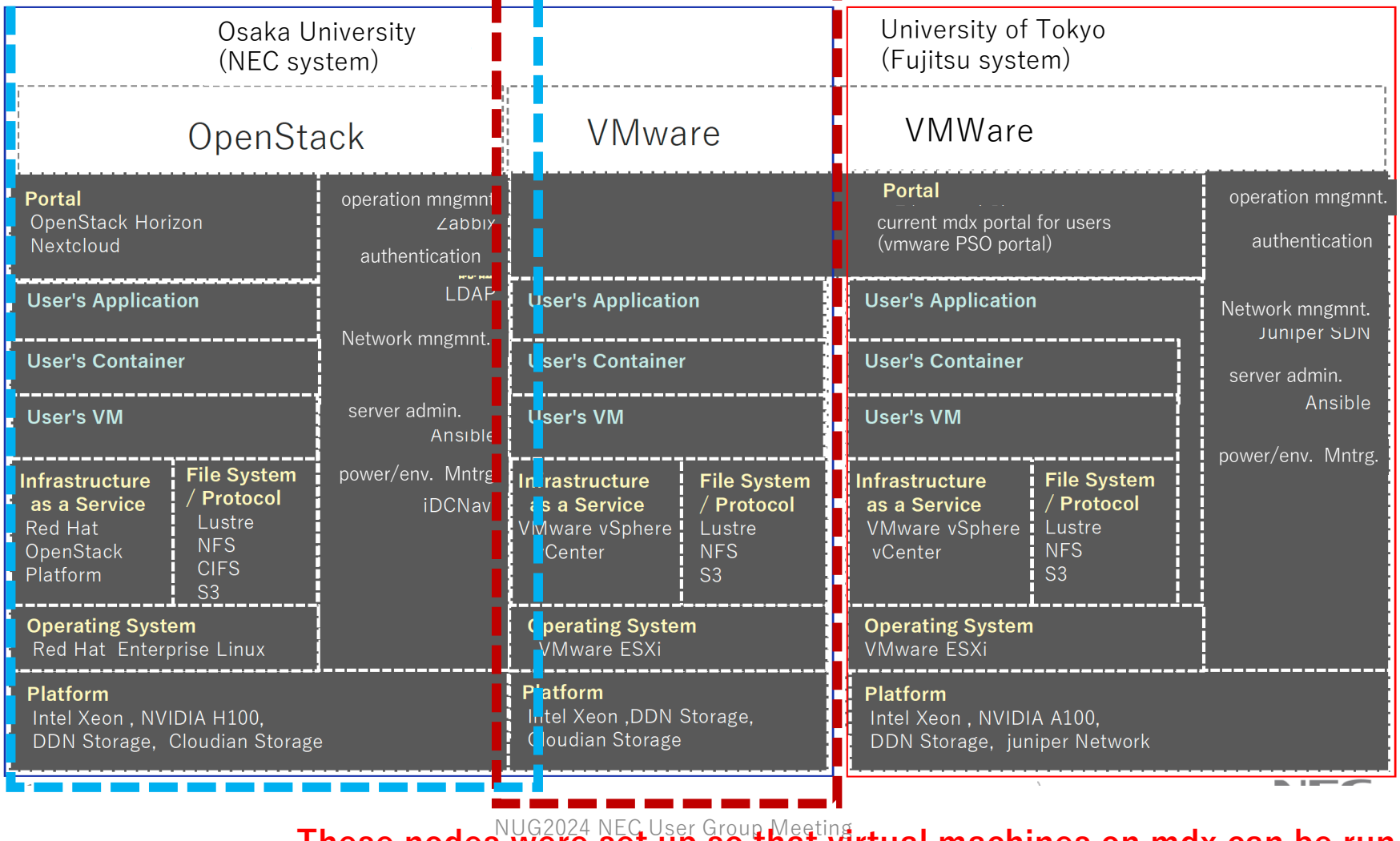


mdx II（as of 2024.04）	
General CPU computing nodes	
60 nodes x Theoretical performance/node 7.168TFLOPS	430.08TFLOPS
processor	Intel Xeon Platinum 8480+ x 2 (Sapphire Rapids/ 56C, 2.0 GHz)
Main memory	512GB (32GB DDR5-4800 ECC RDIMM x 16)
Interconnect	
Inter-node connection	200GbE
Storage	
File system	DDN EXAScaler (Lustre)
Actual size	553.24 TB

By the end of March 2025(Japanese fiscal year 2024), mdx2 system will be expanded. We are currently in the process of procurement.

software stack

These nodes were set up so that virtual machines on mdxII can be executed on OCI.



These nodes were set up so that virtual machines on mdx can be run on mdxII.

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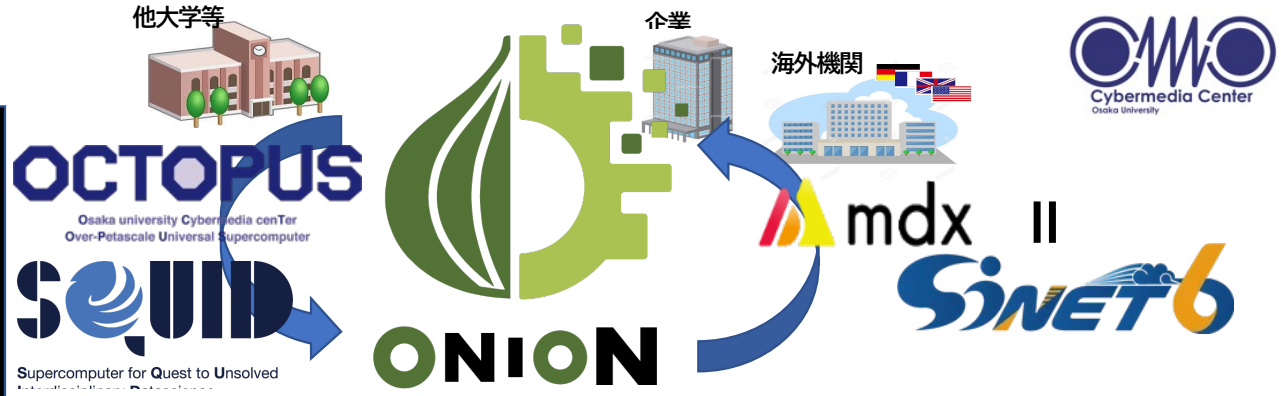
Expectation to mdxII from Osaka University perspective

Acceleration of HPC-related projects using mdx II (CMC perspective)

Towards a research hub that accelerates large-scale data science, by formulating eResearch environment synergizing SQUID/OCTOPUS, mdxII and ONION.



Supercomputing systems

We want to perform computational simulation and numerical analysis (HPC) as well as HPDA characterized with keywords such as DL(Deep Learning), ML(Machine Learning) and AI(artificial Intelligence).

Data aggregation infra. (ONION)

ONION promotes data science activities by probiding the functionalities of aggregating, sharing and managing large-amount of data intuitively and efficiently.

Cloud platform (mdx)

Dynamic deploy and removal of user-dedicated IaaS environment (tenant) **accommodates a diversity of compute needs difficult to satisfy with supercomputing systems.** Also, it helps users to implement and provide their solution as a service.

Large-scale/high-performance

Evaluation towards social feedback

Increasing HPC・HPDA needs

High Performance Scientific Computing News, http://www.hpc.cmc.osaka-u.ac.jp/hpsc-news/

Needs difficult to satisfy using supercomputers

Real-time processing
we want to perform real-time analysis of data retrieved from IoT devices on campus.

Algorithm evaluation
We want to build an environment that emulates composed of 100 compute nodes for evaluating arbitrary network topology among them.

workload offload from labo
We want to use compute nodes just for expanding the labo environment due to the lack of compute resources.

Socieal infra. simulation
We want to perform traffic control simulation to alleviate traffif jam by emulating connected car environment.

OU vision and what CMC envisions.

～OU vision 2021 towards a world-leading innovative university which contributes to social innovation～

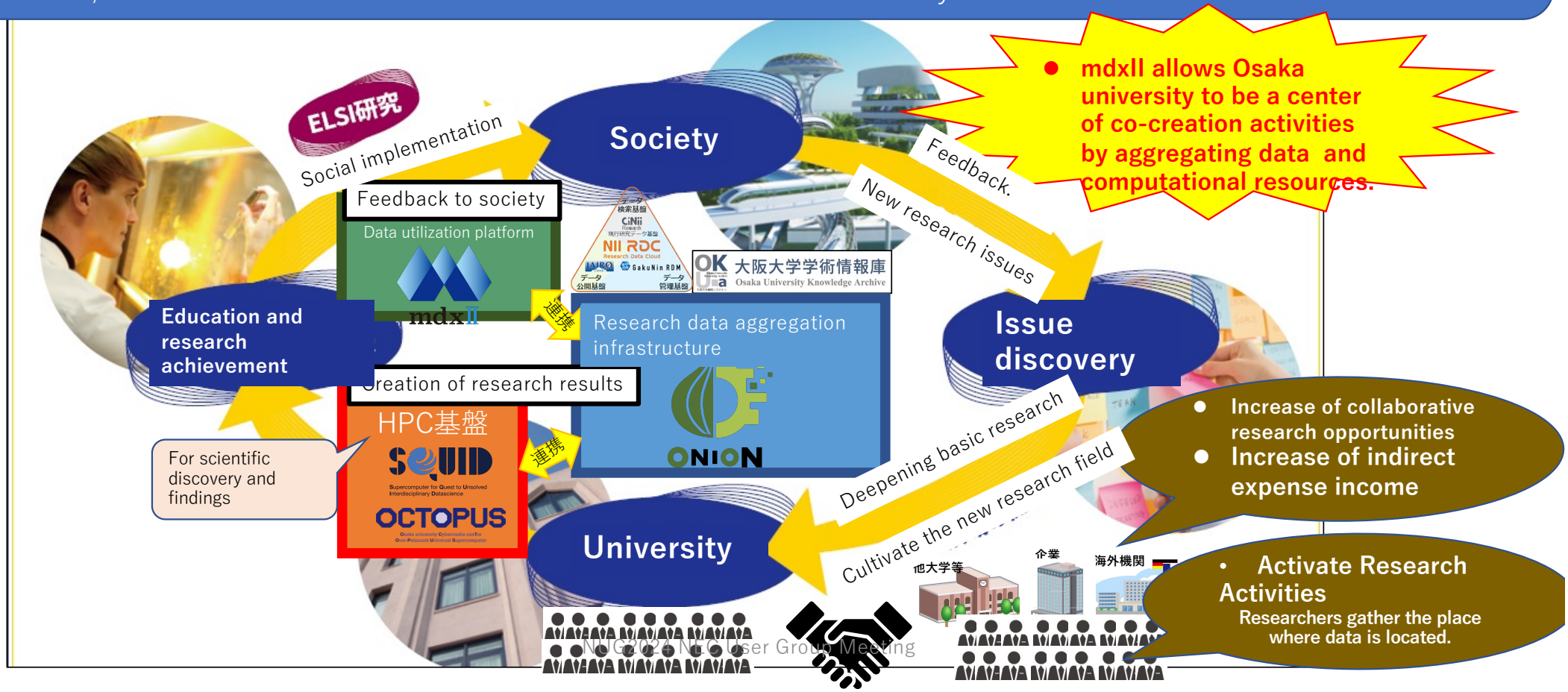
Realization of “University of Society and for Society” leading “Co-creation innovation”
by setting the goal to realize “co-creation” defined by five pillars
“Open Education”,“Open Research”, “Open Innovation”,”Open Community”, and ”Open Governance”

R and D eco system

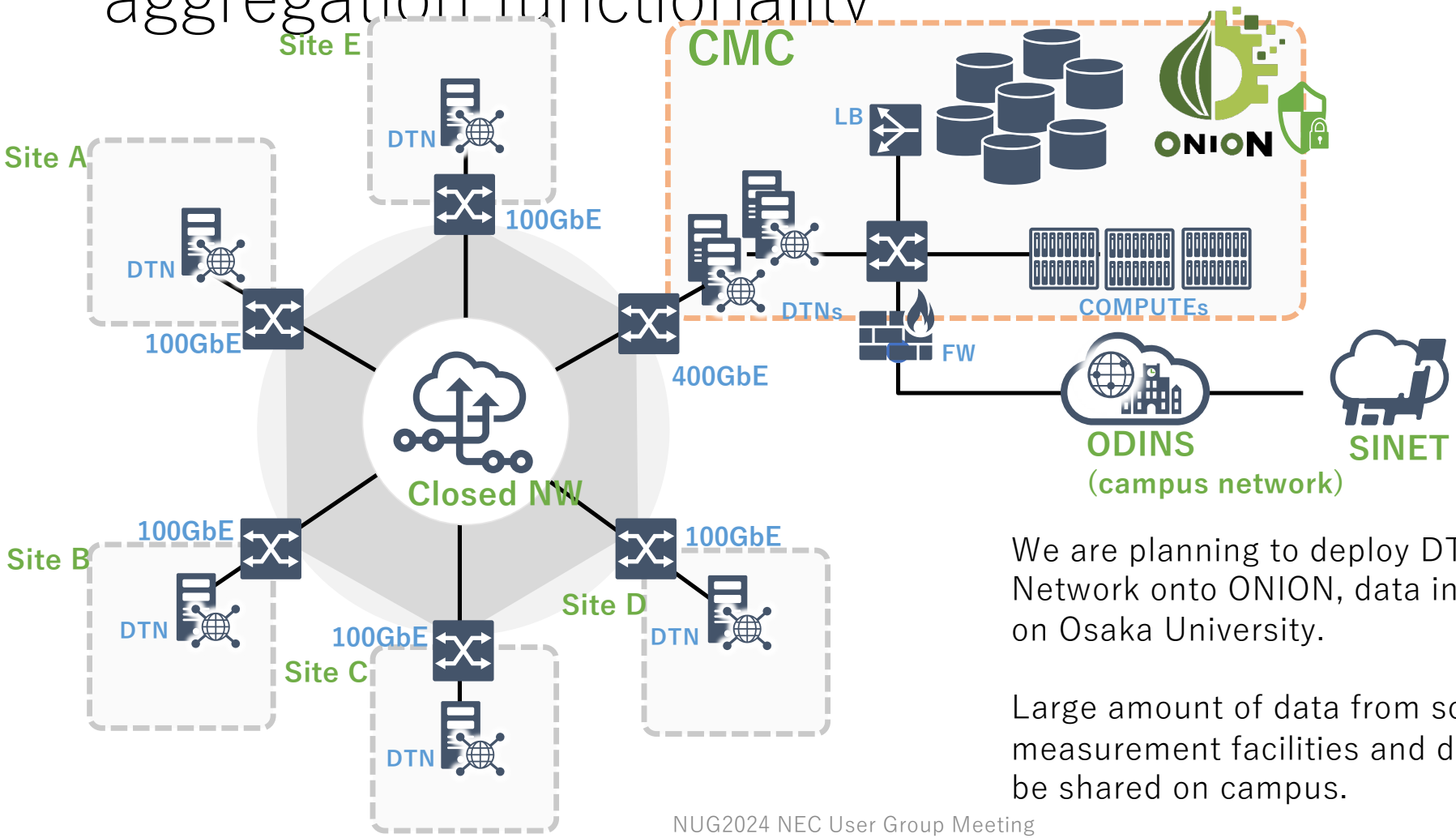
- Formulation of R&D eco-system leveraging supercomputing systems at the Cybermedia Center
- Acceleration of co-creation between academia and industry, international collaboration, and regional cooperation
- Nurturing of future leading human resources

Expectation to the formulation of data utilization hub through mdx II

- We realize the feedback of research results to our society by performing high performance computing using scientific data accumulated on ONION without moving large-amount of money.
- Co-creation activities between academia and industry will be activated on the place where data is located. In other words, mdxII and ONION attracts co-creation activities in Osaka University.



RED-ONION:Reinforcement of data aggregation functionality



We are planning to deploy DTN and high-speed Network onto ONION, data infrastructure on Osaka University.

Large amount of data from scientific measurement facilities and devices can be shared on campus.