HOKKAIDO UNIVERSITY

IXPUG Workshop at HPC Asia 2025

February 19, 2025 @ The Sheraton Hsinchu Hotel, Hsinchu, Taiwan

An Overview of the Next Supercomputer System in Hokkaido University

Takeshi Fukaya

(Hokkaido University, Japan)

Hokkaido University

Dr. William S. Clark
(1st President of Sapporo Agricultural College)

HOKKAIDO UNIVERSITY

Information Initiative Center

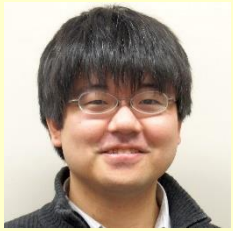
The Information Initiative Center was established in April 2003 for the promotion of advanced research in the development of ICT (information and communications technology) as well as to help the University to construct and maintain its ICT infrastructures. The Center endeavors to promote educational research utilizing ICT and to support the University in carrying out its curriculum based on these developments. In addition to fundamental support to the University, the Center also plays an important role as a resource center for nationwide ICT collaboration in supercomputing and cloud computing.

Information Initiative Center
North Building

Main services

- **Interdisciplinary large-scale computer system (supercomputer & cloud systems)**
- Campus network (HINES: the H
- Activities on cyber security (Cyb

Takayuki Umeda
(Professor)



Takeshi Fukaya
(Associate Professor)

Yuki Satake
(Assistant Professor)

Takeshi Iwashita
(Visiting Professor)

Organization

- Director
  - Board of Delegates
  - Deputy Director
  - Administrative Division
  - Cyber Security Center

Supercomputing Research Division
Sophistication of large-scale scientific computing and R&D of application programs

Media Education Research Division
Research on sophistication of education using ICT/information education and promotion of informatized/open education in the global society

Information Network Research Division
Research on advanced technologies for next-generation information networks, information security and information distribution infrastructure

System Design Research Division
Researches on systems design such as cloud computing and systems design optimization

Digital Contents Research Division
Accumulation, processing, distribution, utilization and other handling of digital data contents

Cyber Security Research Division
Theoretical and practical development with advanced technology and related data analysis on Cyber Security

Topics in this talk

At the end of FY2024, we will replace the Interdisciplinary Large-Scale Computing System (including the supercomputer system) with a new system.

- Review of the current supercomputer system
- Design concept of the next supercomputer system
- Overview of the next supercomputer system
- Typical users in Hokkaido University

History of supercomputer systems

In operation

Nov. 2011 – Jul. 2018	Dec. 2018 – Feb. 2025	Apr. 2025 (- Mar. 2030)
0.172 PFLOPS	3.96 PFLOPS	9.00 PFLOPS
IBM POWER7 HITACHI SR16000 M1	Intel Xeon (Skylake) FUJITSU PRIMERGY CX2550 M4 PRIMERGY CX400 M4	Intel Xeon (EMR) FUJITSU PRIMERGY CX2550 M7
	Intel Xeon Phi (KNL) FUJITSU PRIMERGY CX1640 M1 PRIMERGY CX600 M1	+ NVIDIA GPU (H100) (partial) FUJITSU PRIMERGY GX2560 M7
900 TB (HDD) HITACHI AMS2500	16 PB (HDD) DDN ES14KX	16.95PB (SSD) DDN ES400NVX2

Review of the current system

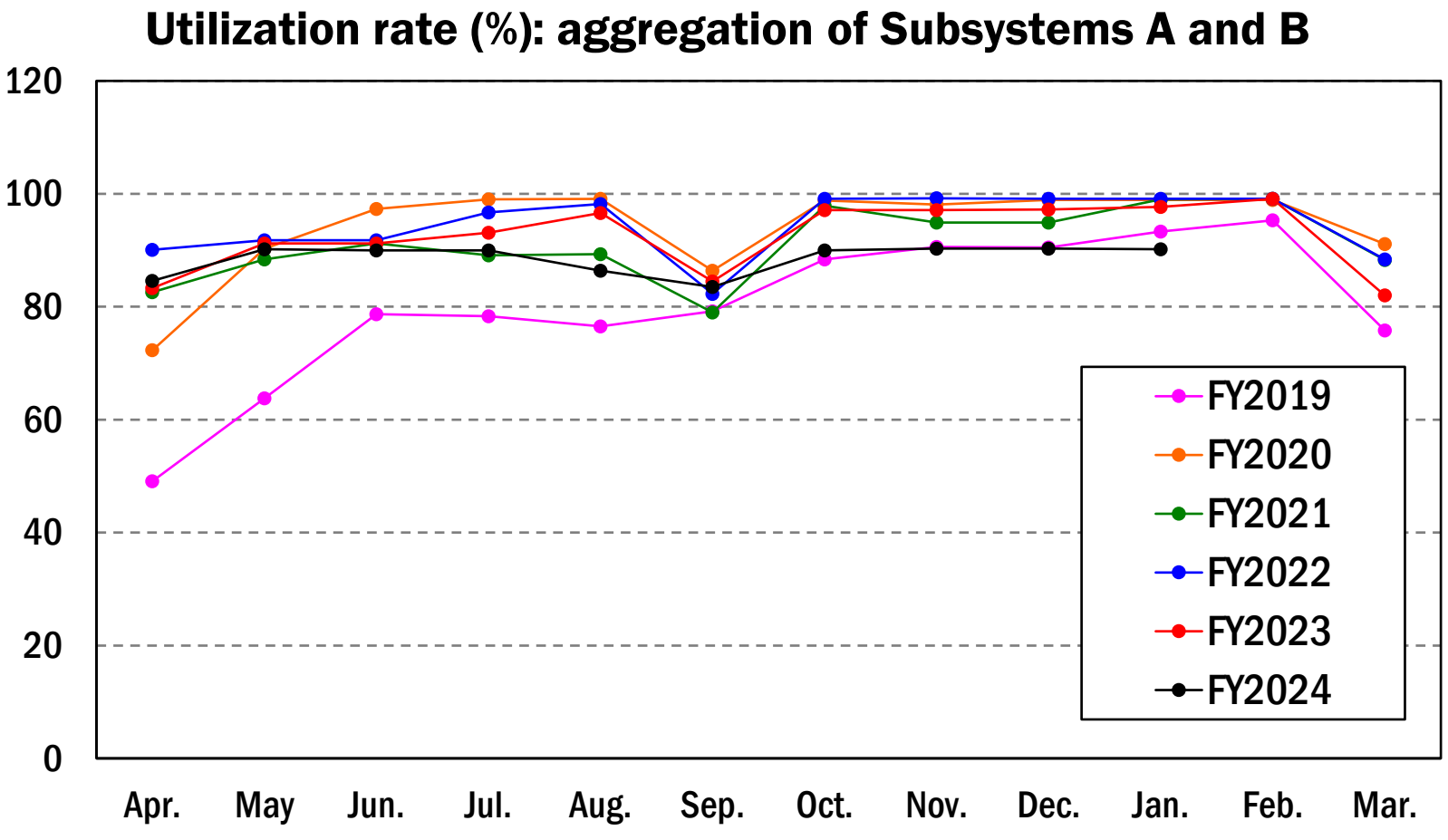
Overview of the current system

Design concept:

- ✓ compatibility with lab-level environments and support for various applications (OSS) → x86
- ✓ consideration of HPC trend → Subsystem B (many-core, step to Fugaku, OFP)
- ✓ service type based on needs from users → exclusive-node use

Subsystem A (Grand Chariot)	Subsystem B (Polaire)	Storage system
FUJITSU PRIMERGY CX2550 M4, PRIMERGY CX400 M4	FUJITSU PRIMERGY CX1640 M1, PRIMERGY CX600 M1	DDN ES14KX
1,004 nodes (3.08 PFLOPS)	288 nodes (0.87 PFLOPS)	16 PB
Node specification: • CPU : Intel Xeon Gold 6148 x2 (Skylake, 20-core) • Memory : 384GB	Node specification: • CPU : Intel Xeon Phi 7250 (Knights Landing, 68-core) • Memory : 96GB + 16GB MCDRAM	• DDN ExaScaler (Lustre)
Interconnect : Intel Omni-Path (Fat Tree)		
Provided service : • exclusive-node use (fixed–rate) and shared-node use (consuming points based on running time) • resources can be shared among users in a group.		

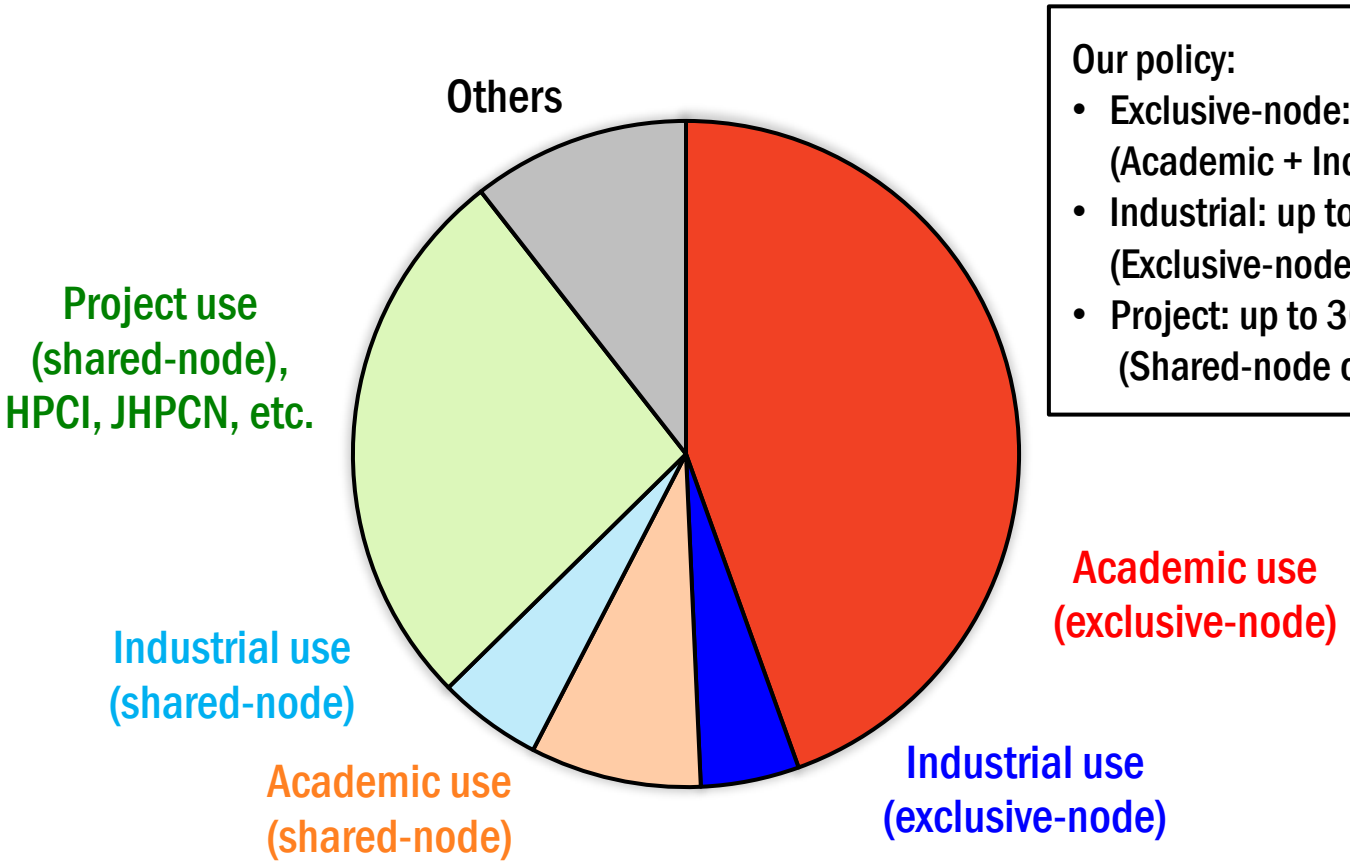
Usage status of the current system (I)



Note: utilization rate = aggregated time charged by users / total operation time

Usage status of the current system (II)

Breakdown of use-type of Subsystem A in FY2024 (100%: 1004 node-year)



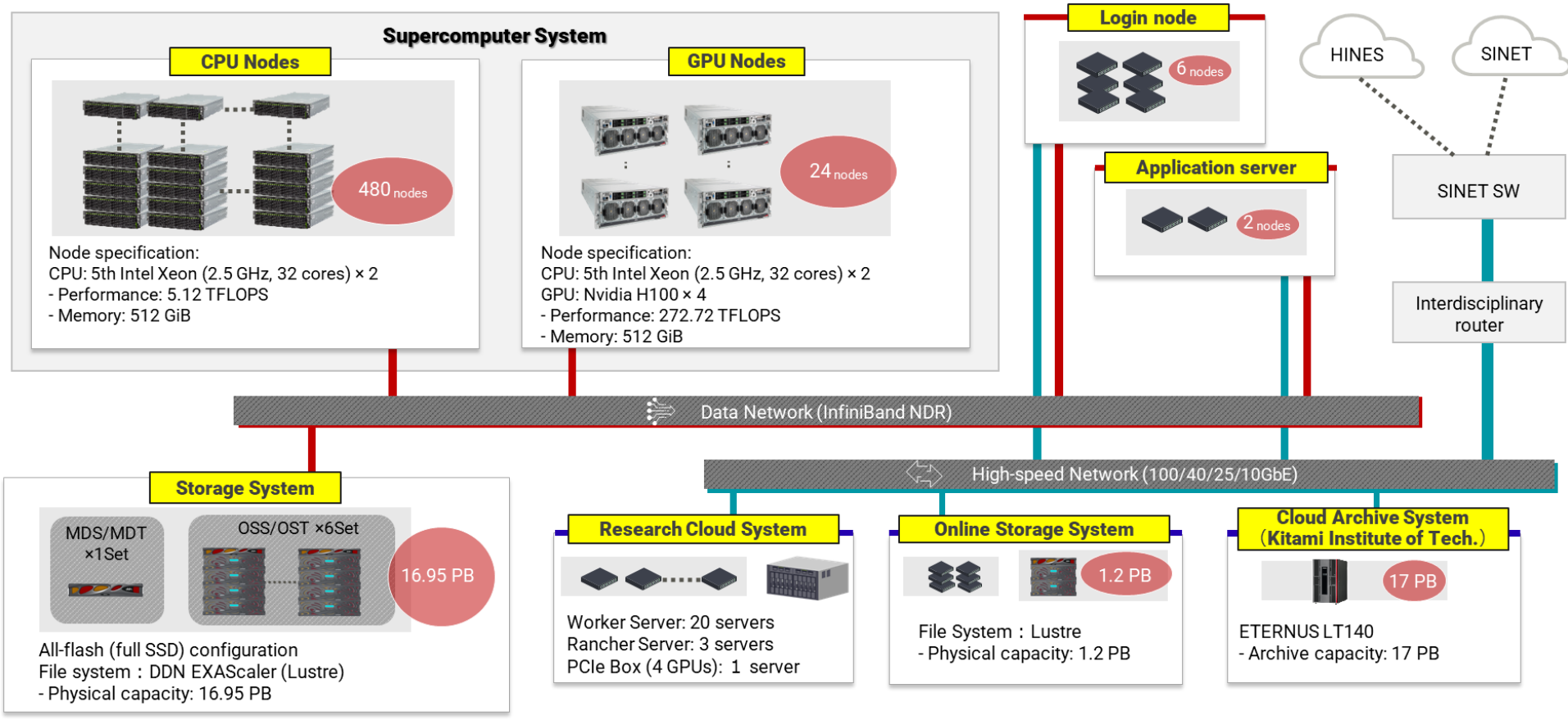
Our policy:
- Exclusive-node: up to 50% (Academic + Industrial)
- Industrial: up to 10% (Exclusive-node + shared-node)
- Project: up to 30% (Shared-node only)

Design concepts for the next system

- Review of the current system
  - ✓ High utilization rate (regardless of use-type)
  - ✓ Applications of (traditional) computational science (with OSS)
  - ✓ Many users in Hokkaido University
  - ✓ High demand for exclusive-node use
- Design concept for the next system
  - ✓ Compatibility with lab-level environments and support for various applications
  - ✓ Consideration of HPC trend
  - ✓ Addressing the need of AI and ML fields
  - ✓ Preserving the service courses with high demand in the current system
  - ✓ Considering installation condition (e.g., building renovation)

Next system (supercomputer & others)

Next Interdisciplinary Large-Scale Computing System
(official operation of supercomputer will start in Jul. 2025)



Overview of the next supercomputer

Concept: standard CPUs + GPUs (partial), basically same service coerces

Computing subsystem (Grand Chariot 2)		Storage system
CPU-node group	GPU-node group	
FUJITSU PRIMERGY CX2550 M7	FUJITSU PRIMERGY GX2560 M7	DDN ES400NVX2
480 nodes (2.457 PFLOPS)	24 nodes (6.55 PFLOPS)	16.95 PB
Node specification: • CPU : Intel Xeon Gold 6548Y+ x2 (Emerald Rapids, 32-core, 2.5GHz) • memory : 512GB	Node specification: • CPU : Intel Xeon Gold 6548Y+ x2 (Emerald Rapids, 32-core, 2.5GHz) • NVIDIA H100 x4 • memory : 512GB	• DDN ExaScaler (Lustre) • All flush (full SSD)
Interconnect: InfiniBand NDR (400Gbps, Fat Tree)		
Provided service : • exclusive-node use (fixed–rate) and shared-node use (consuming points based on running time) • resources can be shared among users in a group. • unit of usage: by CPU socket (CPU-node), by GPU bord (GPU-node)		

Software stack

- OS:
  - ✓ Red Hat Enterprise Linux 9 (login node)
  - ✓ Rocky Linux 9 (computing note)
- Job scheduler:
  - ✓ PBS Pro. (with customization)
- SDK:
  - ✓ Intel oneAPI
  - ✓ NVIDA HPC SDK, CUDA Toolkit
- Container:
  - ✓ Docker, Singularity Community Edition
- OSS:
  - ✓ CS (GROMACS, PHASE, Quantum ESPRESO, LAMMPS, etc.)
  - ✓ AI/ML (Tensorflow, Py Tourch, etc.)

Preparation for the start of operation

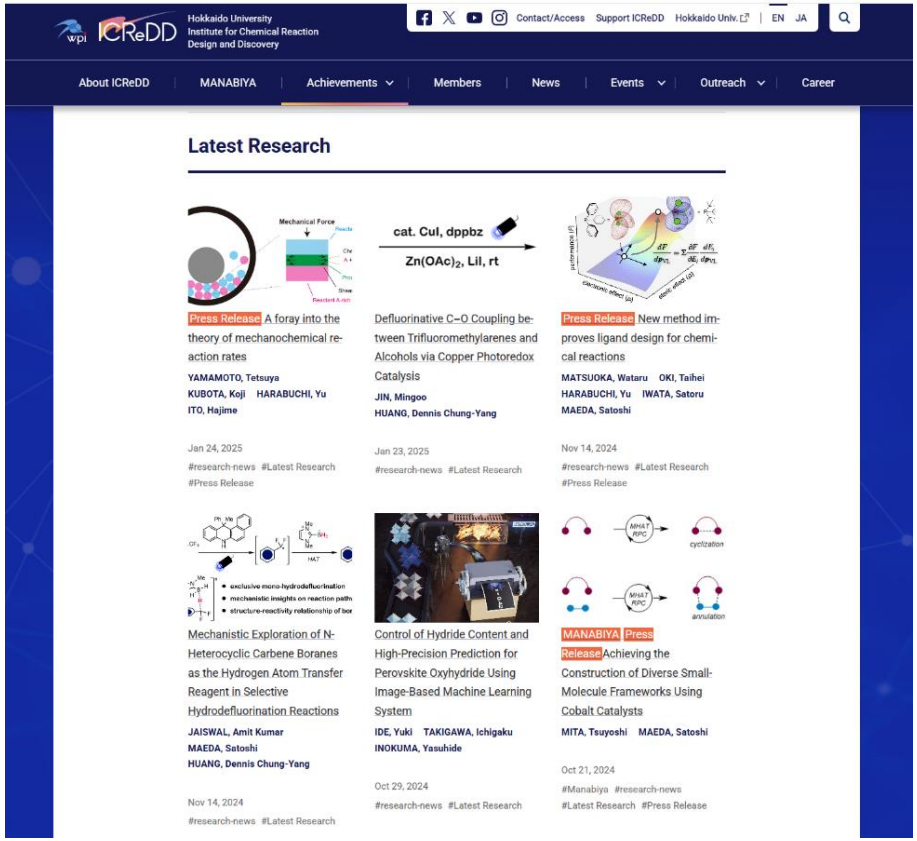
Official operation is planned to start at the beginning of Jul. 2025.

- ◆ Current status
  - ✓ Usage fee has been almost determined.
  - ✓ Design of job classes (and assigned resources) has been fixed.
- ◆ Promotion of the use of GPU
  - ✓ We are looking for GPU users in Hokkaido University.
  - ✓ We plan support programs of GPU-use (under collaboration with other universities)
- ◆ Other tasks
  - ✓ We consider making rules for educational use.

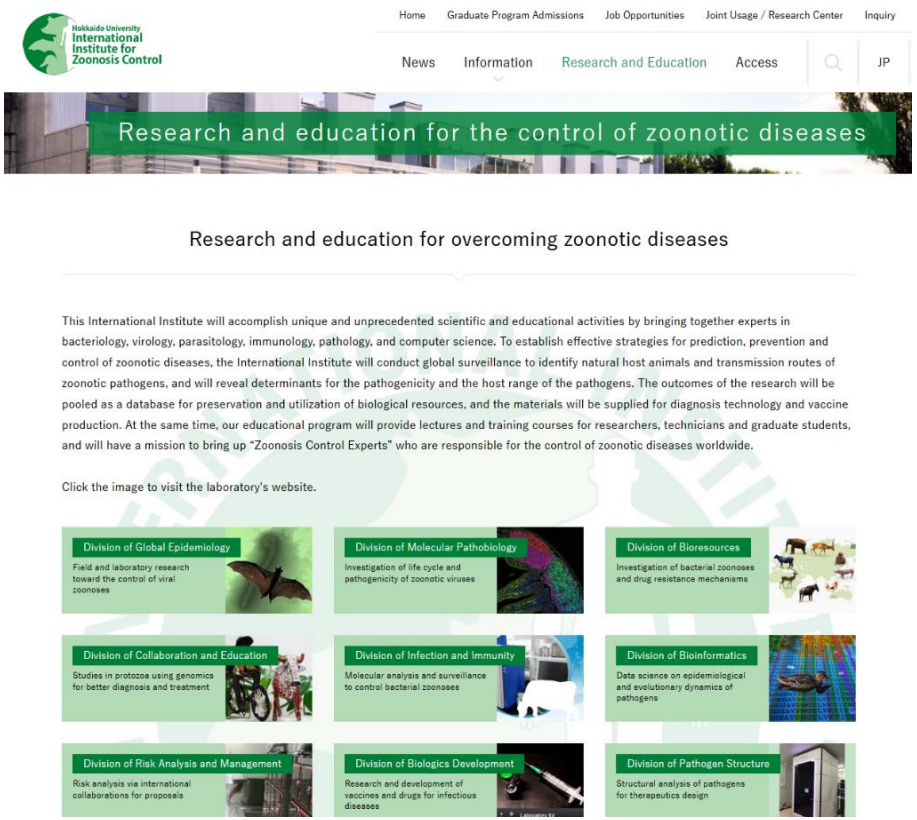
Current status of installation

Tyical users in Hokkaido University

Institute for Chemical Reaction Design and Discovery (ICReDD)

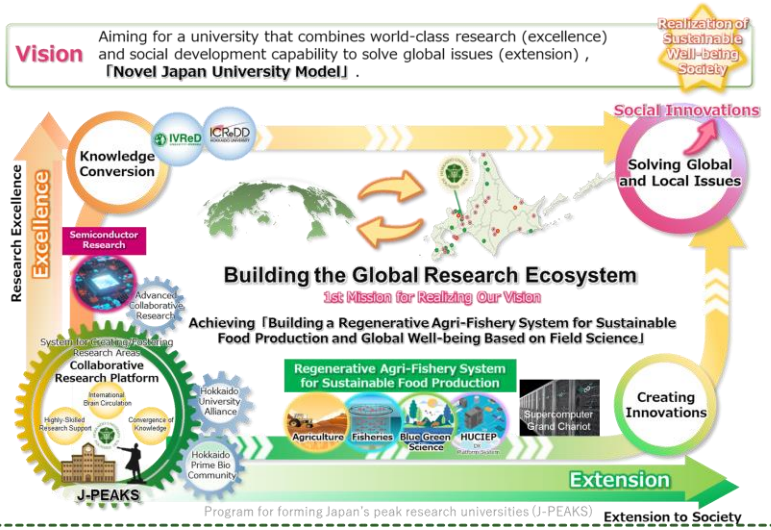


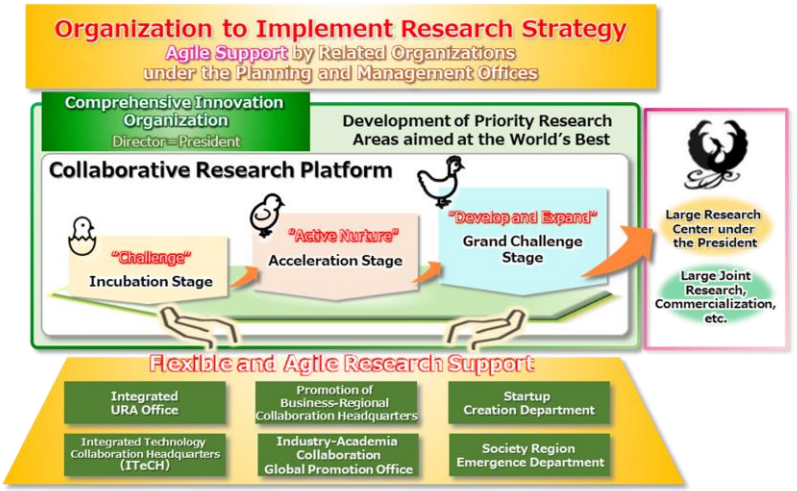
International Institute for Zoonosis Control



Expected new users for the next system

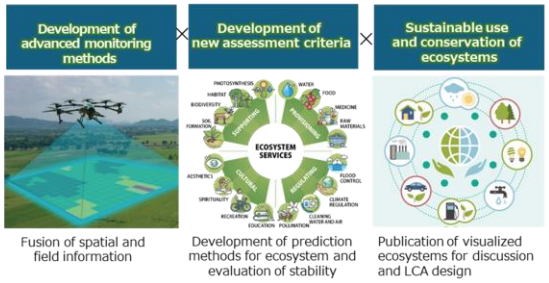
Program for forming Japan's peak research (J-PEAKS) in Hokkaido University





Green and Blue Field Science

Human activities are changing ecosystems, irreversibly reducing biodiversity, degrading ecosystems, and increasing nonlinear risk. We spatially assess forest and marine (green and blue) ecosystem functions, predict environmental responses and recovery rates, and attempt to develop conservation measures for sustainable use, maintenance, and restoration of ecosystems.



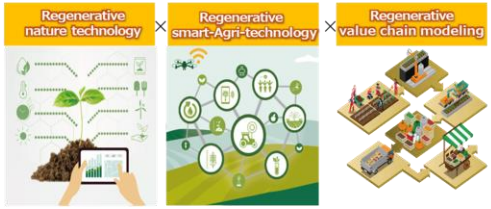
Fusion of spatial and field information

Development of prediction methods for ecosystem and evaluation of stability

Publication of visualized ecosystems for discussion and LCA design

Agriculture/Paradigm shift in food production system.

The world's food production is undergoing a major transformation toward regenerative agriculture. In order to trigger this shift using Hokkaido as a model, we will construct a food production/consumption system that regenerates the value of local society and environment through understanding the interaction between agriculture and ecosystems, and through innovation of agricultural methods using advanced technology.



Understand ecosystem services (microbial functions, etc.) related to agriculture by making full use of data science.

Rationally design environmentally regenerative agricultural methods using AI/IoT technology and advanced biotechnology.

Research on transition to environmentally regenerative methods and create a value chain to create that value.

Fisheries/Paradigm shift in food production system

We will develop a **"custom-made regenerative fisheries system that combines fishing and aquaculture"** through smart fisheries technology using ICT/IoT to visualize and understand the potential of coastal, seaweed bed, and marine resources, and through fisheries system science to realize sustainable marine product production, while conserving and maximizing their potential. **Regenerative Fisheries System** will be developed.

Development of natural resource utilization/control and recycling/production-oriented aquaculture technology

Development of fisheries monitoring and assessment technology utilizing IoT, ICT, etc.

Development of related technologies for the construction of highly flexible and advanced processing plants and cold chains

Conclusion

- Current supercomputer system
  - ✓ x86 architecture (Skylake Xeon & KNL) was employed for support various applications (OSS), which has been accepted by many users.
  - ✓ Exclusive-node use was introduced, which has had high demand.
  - ✓ Throughout its operation, high usage rate has been achieved (without serious system troubles).
- Next supercomputer system
  - ✓ Intel Xeon (EMR) + partially NVIDIA GPU (H100)
  - ✓ We basically preserve the same concept and service as in the current system.
  - ✓ We newly introduce GPUs for the need in AI and ML (and current HPC trend).
  - ✓ To find GPU users and support them are one of our important tasks.
  - ✓ Official operation will start in Jul. 2025 (and installation is on schedule).