NARLabs National Applied Research Laboratories
National Center for High-performance Computing

Unlocking the Power of Supercomputing: Exploring the HPC/AI Facilities and Applications at NCHC

Steven Shiau

2025/2/19

HPC |
DRIVING TRANSFORMATION
FOR A BETTER FUTURE

National Center for High-performance Computing

Agenda

- About NCHC
- Infrastructures and platforms
- International Collaborations

About NCHC

National Center for High-performance Computing (NCHC)

NCHC is **Taiwan's primary facility for high performance computing (HPC)** with missions to provide services for large-scale computational science and engineering, AI, visualization and virtual reality, data storage, networking, and HPC training.

NCHC is also responsible for the operation of the **100 Gbit/s Taiwan Advanced Research and Education Network** (TWAREN), the national education and research network of Taiwan.

In addition to providing HPC services, NCHC also **develops HPC-related technologies** that support Taiwan's academia and industry with software platforms, advanced research and application development, and professional training.

Position

NSTC 國家科學及技術委員會
National Science and Technology Council

- NSTC is a statutory agency of Executive Yuan of the Republic of China (Taiwan)
- Established for the promotion and funding of academic research, development of science and technology, and the oversight of Taiwan’ s science parks.

NARLabs 國家實驗研究院
National Applied Research Laboratories

- NARLabs is **funded by NSTC**
- Non-profit research institution in charge of providing necessary R&D platforms and bridging technologies for the academia and industry located in Taiwan’s science parks.

  - To establish R&D platforms
  - To support academic research
  - To promote frontier science and technology
  - To foster high-tech manpower

NARLabs 財團法人國家實驗研究院
國家高速網路與計算中心
National Center for High-performance Computing

- NCHC was founded In 1991, merged with NARLabs in 2003
- One of seven national research laboratories under NARLabs
- Taiwan's only national-level supercomputing center.

Vision and Mission

Be the Taiwan AI-HPC Enhancer

Enable Scientific Discoveries & Technical Innovation through prospective computing technology and platform

- Building World Class HPC, AI & Big Data Platform
- Together, Stronger with Customers

Milestones

1991
Taiwan's first National level supercomputer Center

2003
NPO under NARLabs

2004
TWAREN Services 10G

2011
WINDRIDER
177 TF

2016
100G Network Backbone

2017
台灣杉一號 TAIWANIA 1
1.7 PF

2018
台灣杉二號 TAIWANIA 2
9 PF
AI-HPC
NV_V100*2016

2021
台灣杉三號 TAIWANIA 3
2.7 PF

2021
Forward-looking Infrastructure Development Program
→ Start building self-build fiber backbone (phase1)

2022
*information security level A
*Formosa Open Internet Exchange activated

2023
TAIDE Project
Trustworthy AI Dialogue Engine
3.8 PF
NV_ H100*9

2023
self-build fiber backbone (phase1) activated

2024
Forerunner 1
is expected to begin services
3.53 PF

2025
NCHC IDC (Tainan)
scheduled for opening

2025-2029
Computing power plan
Target 480 PF

Computing Power Plan

2024-2028

Taiwan CHIP-BASED Industrial Innovation Program

To support the Taiwan Chip-based Industrial Innovation Program, NCHC will develop a shared heterogeneous architecture supercomputer for general-purpose AI (GPU), large-scale scientific research (CPU), and future quantum computing. We aim to create a user-friendly cloud service platform to improve application efficiency.

2024

16 PF GPU

- 400+ GPUs
- 10 PB storage
- InfiniBand 200Gbps
- PUE <1.35

2025

100 PF GPU

- 1680+ GPUs
- 25 PB storage
- InfiniBand 200Gbps
- PUE <1.3

2026

80 PF GPU+CPU

- 1200+ GPUs
- 20 PB storage
- InfiniBand 400Gbps
- PUE <1.27

2027

35 PF GPU+CPU

- 520+ GPUs
- 10 PB storage
- InfiniBand 400Gbps
- PUE <1.25

2028

49 PF GPU+CPU+Quantum

- 700+ GPUs
- 10 PB storage
- InfiniBand 800Gbps
- PUE <1.25

Total 280PF

2029

Total 200PF

60 PF GPU+CPU

- 1000+ GPUs
- 15 PB storage
- InfiniBand 400Gbps
- PUE <1.25

75 PF GPU+CPU

- 1260+ GPUs
- 25 PB storage
- InfiniBand 800Gbps
- PUE <1.25

65 PF GPU+CPU

- 1020+ GPUs
- 20 PB storage
- InfiniBand 800Gbps
- PUE <1.25

2027-2029

“New Silicon Valley” in southern Taiwan Project

The National Science and Technology Council announced the launch of a new national program in August 2024, planning to invest in the development of Taiwan's own artificial intelligence platform over the next five years to promote the smart technology industry ecosystem in southern Taiwan. The plan will establish 200 PF of computing power and increase the nation's overall computing power to 480 PF.

Locations & Certifications

1993 Hsinchu Headquarter

2005 Tainan Office

2008 Taichung Office

2018 Sha lun Office

2025 Tainan IDC

ISO 50001
Energy Management System

ISO 27018
Personal privacy information protection

ISO27701
Personal Information Management

ISO 27017
Secure cloud environment

ISO DCOS
Data Center Operation Standards

ISO 27001
Information security management system

ISO/IEC 20000
Information Services Management

ISO 9001
Quality Management

ISO PLUS AWARD
Change and Innovation ManagementQuality Model Award

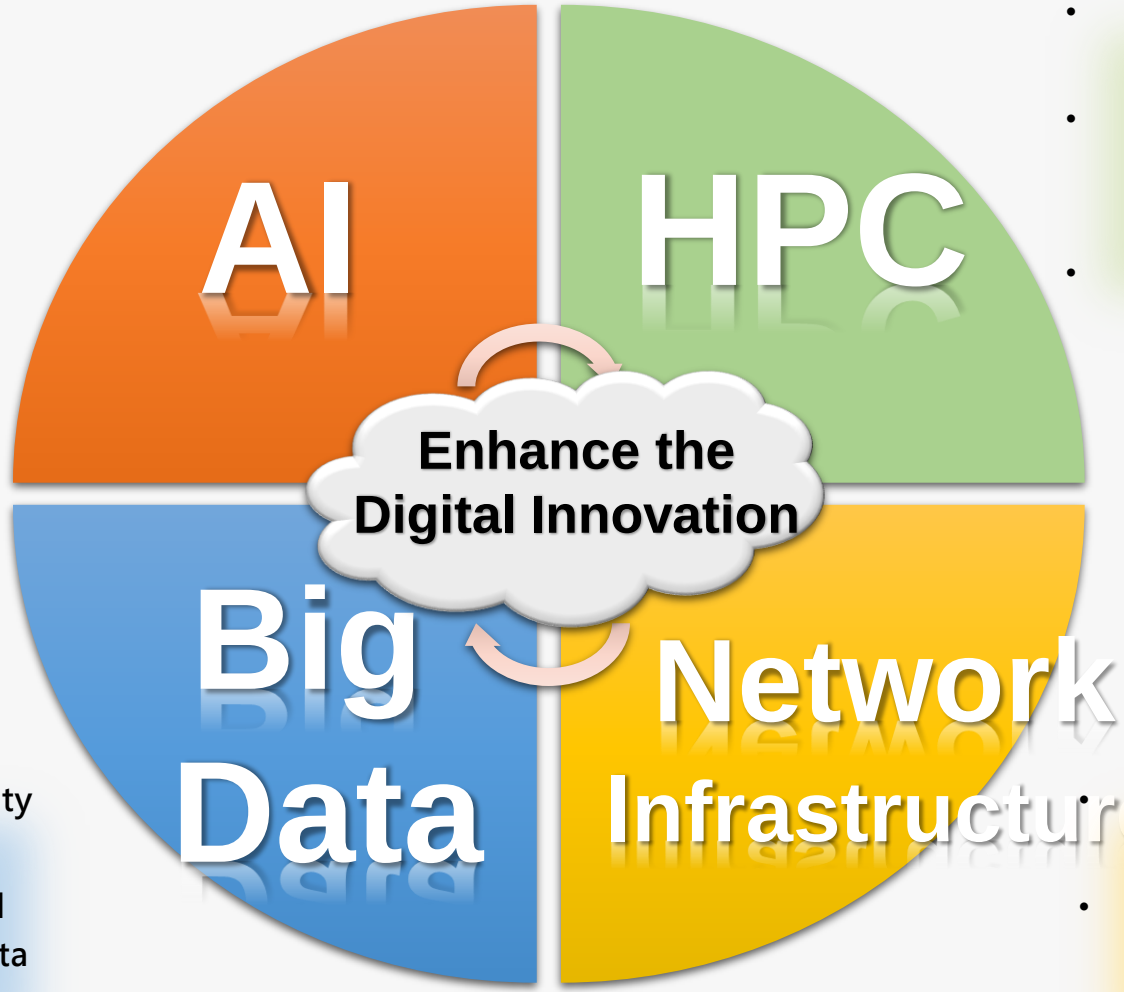
Healthy Workplace Certification
Government issued

NCHC is the only research institution in the country that has obtained the most complete certifications related to cloud services.

It provides advanced HPC computing power, a comprehensive cloud platform, and high-speed networking infrastructure.

4 Major Mission Pillars

- Deploy National Medium to Long-Term Large AI Computing Power
- Provide a GenAI Model Service Platform
- Facilitate the Release and Practical Application of GenAI Models
- Accelerate the Independent R&D of GenAI in Our Country and International Integration



- Promote Key National Projects for High-Performance Computing
- Provide a High-Quality and Reliable R&D Environment for Computing
- Deepen the Cultivation of High-Performance Computing Talent

- Establish a Multi-Domain Big Data Specialty Cloud Service Platform
- Provide a Highly Trusted Environment and Dedicated Cloud Services for Sensitive Data
- Promote Innovative Value in Data Reuse in Our Country

- Establish National-Level Broadband Network Infrastructure
- Enhance the Capacity of Cloud Data Center Services in Southern Taiwan
- Strengthen the Overall Network Resilience of Our Country

Build a Cloud Big Data Computing Ecosystem

Mission Structures

Service

Data Platform

- LIONS 國網生科雲 Bio info Platform
- SciDM 資料集平台 Science Data Market
- 惡意程式知識庫 Malware Knowledge Base
- CDX Cyber Defense Exercise
- 科學園區資安資訊分享與分析中心 Science Park Info Sharing and Analysis Center
- Civil IoT Taiwan
- Taiwan Data Cube
- Smart City
- AI image recognition

Core Technology

- LLM service
- Render Farm
- 3D GIS
- Digital Terrain Model Value-added application platform
- Science and Engineering Simulation
- VR/AR
- Trustworthy Cloud

Infra-structure

High performance computers

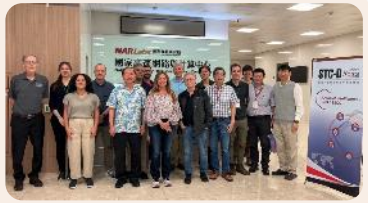
High performance storage equipment

High quality academic research network

Talent Cultivation

NCHC cultivates talents through

- Campus camps
- Advanced courses
- Seminars & Workshops
- Competitions in the HPC field
- Academic cooperation programs



Research

- HPC/AI Application
- Cyber-Physical System (CPS) & Simulations
- Next Gen HPC/QC
- Privacy Enhancement Technologies (PETs)
- Forward Thinking Research

Infrastructures and platforms

NCHC HPC History

800+ million Computing hours per year

1800+ Projects per year

900+ User papers per year

6000+ Users per year

On-line

1 EF

台灣杉二號 TAIWANIA 2
TOP500 #20
(2018/11)
9 PFLOPS

台灣杉二號 TAIWANIA 2 +TAIDE H100
3.8 PFLOPS

Forerunner1
3.53 PFLOPS

台灣杉三號 TAIWANIA 3
2.7 PFLOPS
TOP500 #181
(2020/11)

台灣杉 TAIWANIA
TOP500 #95(2017/11)
1.7 PFLOPS

1 PF

IBM Cluster 1350
TOP500 #35
(2007/6)
19.9 TFLOPS

御風者 WINDRIDER
TOP500 #42
(2011/6)
177 TFLOPS

1 TF

973 GFLOPS
Formosa 1
TOP500 #135
(2003/6)

590 GFLOPS
IBM P690
TOP500 #60
(2002/6)

14 GFLOPS
IBM SP2/80
TOP500 #76
(1996/6)

1 GF

1996 2002 2003 2007 2011 2017 2018 2020 2023 2024

Major HPC System in service – Taiwania 2

台灣杉二號
TAIWANIA 2

TAIWANIA 2
9
petaflops
Rmax

- Build in 2018
- The first HPC Cloud in Taiwan
- GPU : 2,000 Nvidia V100
- VM : 3,000+
- Max Performance ： 9 PF

Major HPC System in service – Taiwania 2

台灣杉二號
TAIWANIA 2

TAIWANIA 2
9
petaflops
Rmax

- **Storage : 10 PB GPFS for HPC**
  2PB Block for VM
  30PB Obj for S3
- **193.5 TB of main memory**
- **Networks : Infiniband HDR 100Gbps**
- **Efficiency : 11.28 GFLOPS/W**
- **PUE< 1.2 (Warm Water Cooling)**

NCHC AI Platform - TWCC

TWCC
TAIWAN COMPUTING CLOUD

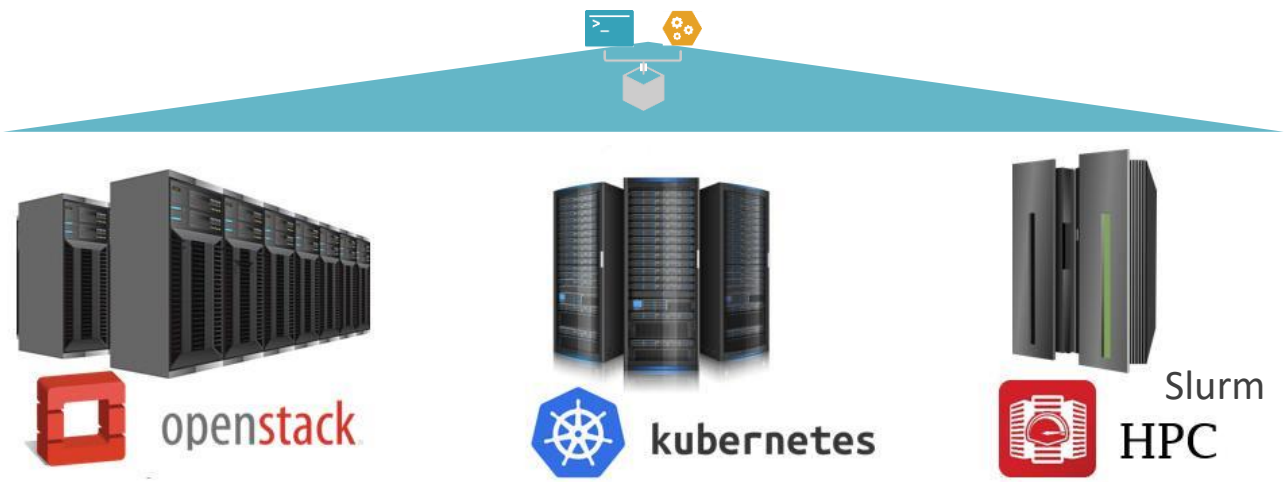
HPC service

Virtual machine
compute service

Container compute service

Cloud Object/Block Storage

台灣杉二號
TAIWANIA 2
System Architecture



Major HPC System in service – Taiwania 3

台灣杉三號
TAIWANIA 3

TAIWANIA 3
2.7
petaflops
Rmax

- Build in 2020
- CPU cores : 50,400
- Max Performance ： 2.7 PF

Major HPC System in service – Taiwania 3

台灣杉三號
TAIWANIA 3

TAIWANIA 3
2.7
petaflops
Rmax

- **Storage : Share with Taiwania 2**
- **172 TB of main memory**
- **Networks : Infiniband HDR 100Gbps**
- **Efficiency : 4 GFLOPS/W**
- **PUE< 1.3 (Rear door Cooling)**

Major HPC System in service – Forerunner 1

3.5
petaflops
Rmax

- Build in 2023
- CPU cores：61,824 X86 Cores and 5,760 ARM Cores
- Max Performance：3.5 PF for x86 Core
- Heterogeneous system：Integrating both X86 and ARM architectures

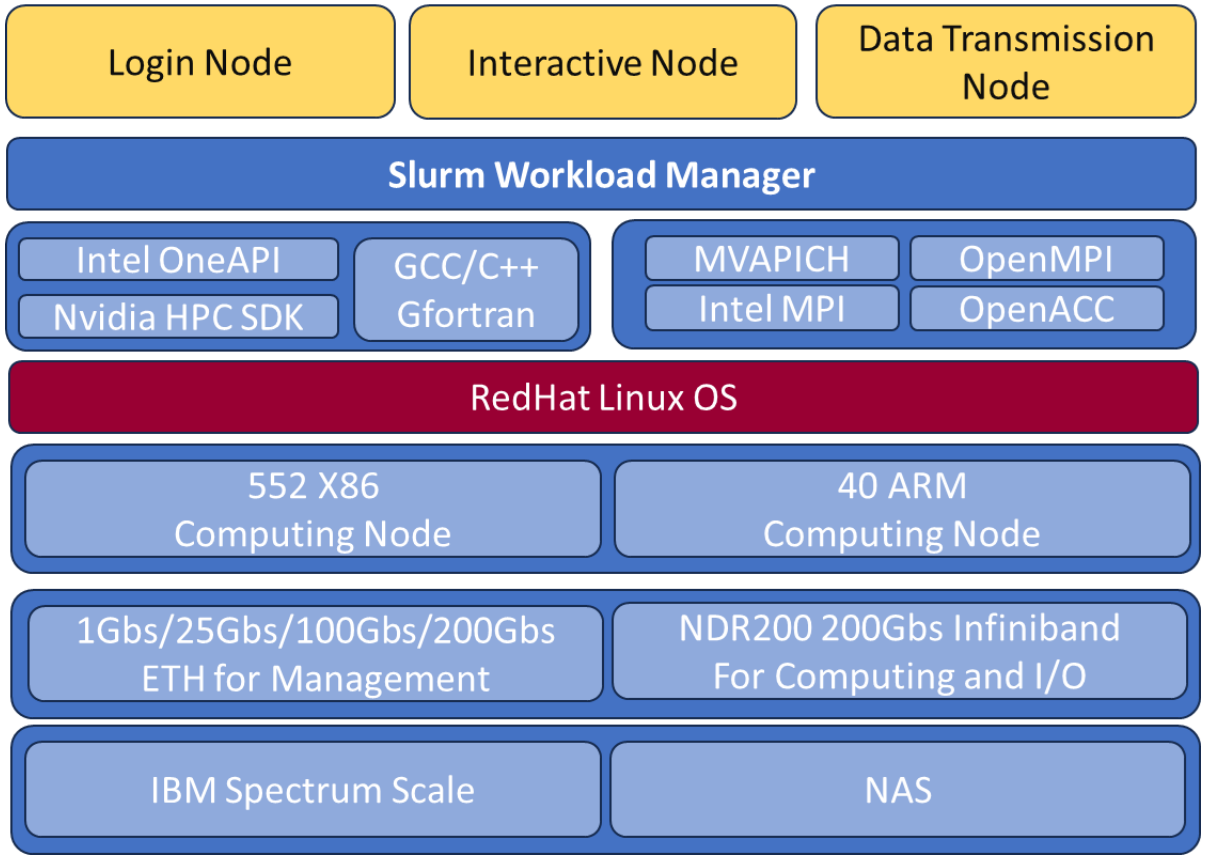
Major HPC System in service – Forerunner 1

3.5
petaflops
Rmax

- Storage : 9.2PB
- 141 TB of main memory
- Networks : Infiniband HDR 200Gbps
- PUE< 1.28 (Direct-to-chip cooling Rear door Cooling)

Major HPC System in service – Forerunner 1

System Architecture for Forerunner 1

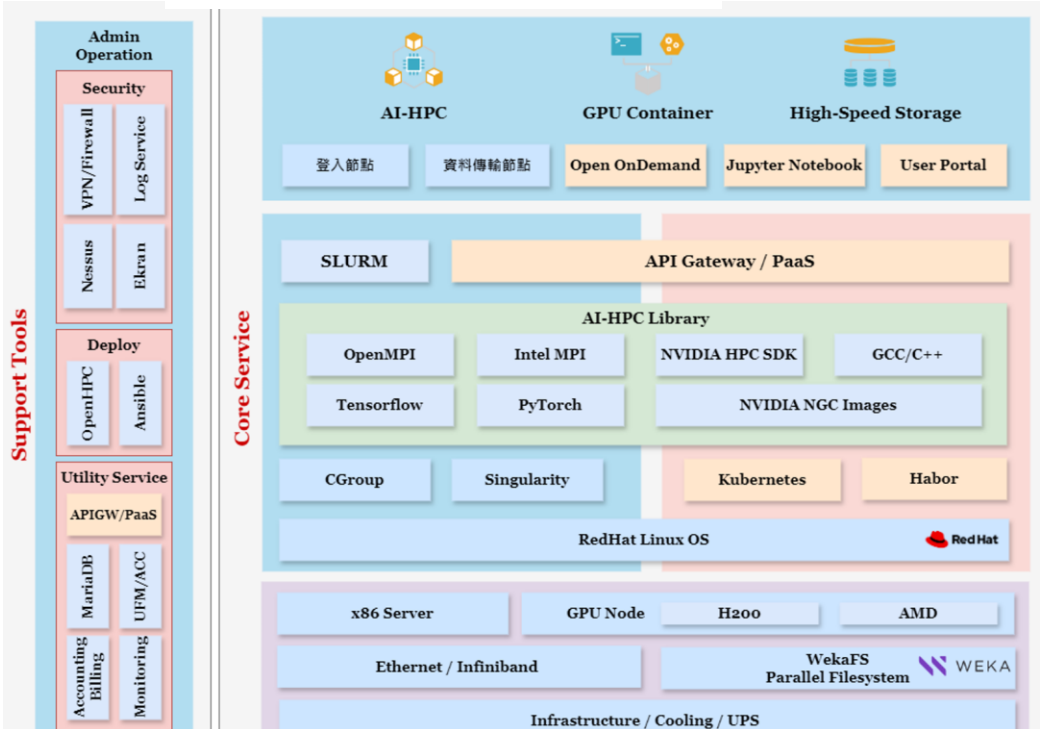


Software library and tools: ANSYS, ABAQUS, LD-DYNA, GAUSSIAN, Q-

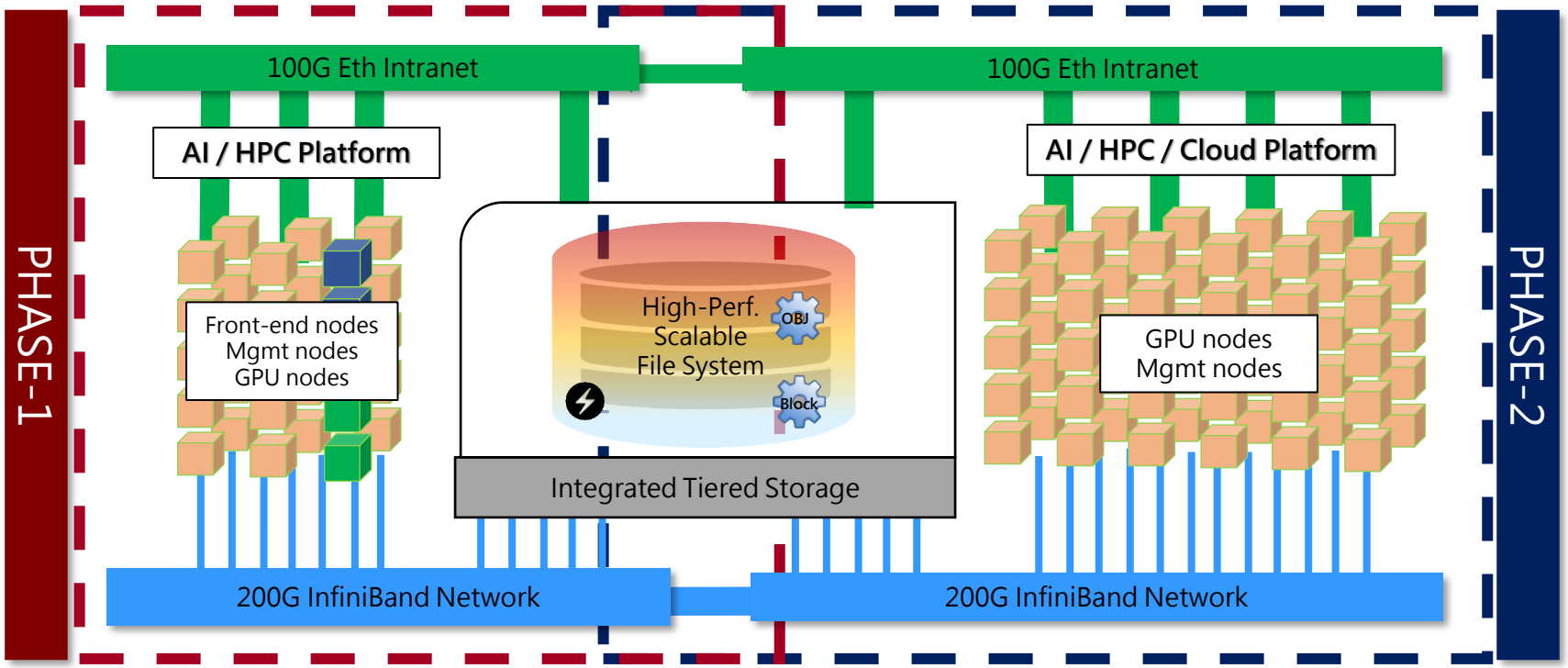
AI-Platform – Nano 5

- Phase 1 - Build an AI-HPC System in Q1 2024
  - 12 HGX H100 Nodes with Intel Xeon CPU
  - 9 DGX H100 Nodes
  - Infiniband NDR400
  - 4 PB HDD (WEKA)
- Phase 2 - Build an AI-Cloud system in Q4 2024
  - 16 HGX H200 Nodes with Intel Xeon CPU
  - 4 MI300X Nodes with AMD EPYC CPU
  - Infiniband NDR400
  - 100Gbs Ethernet
  - 6 PB All-Flash SSD (WEKA)

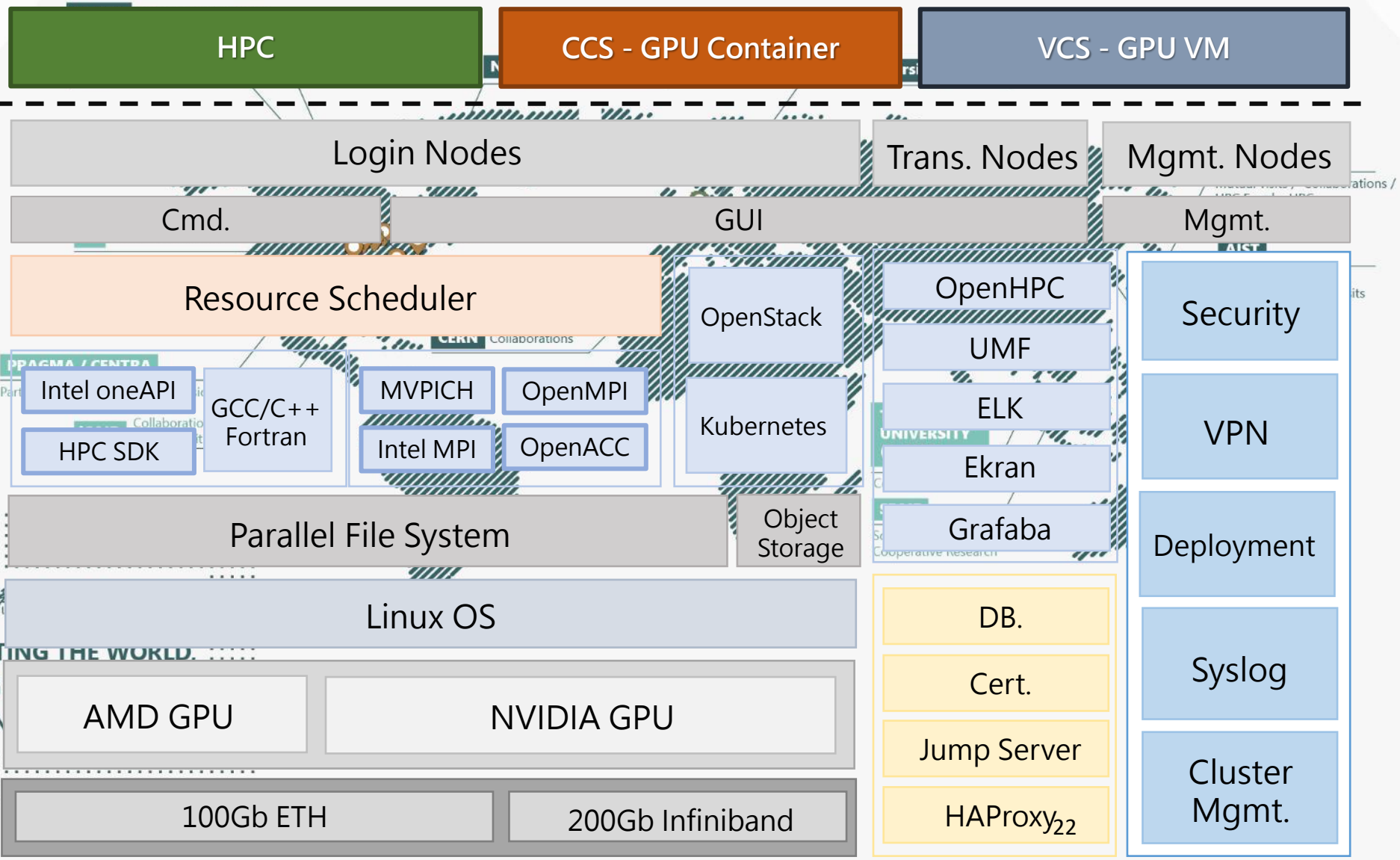
- Totally 296 H100/H200, 32 MI300x. Online in 2025/May



System Architecture



Software Stack



Looking Forward

Computing power and cloud construction

Network and data center construction

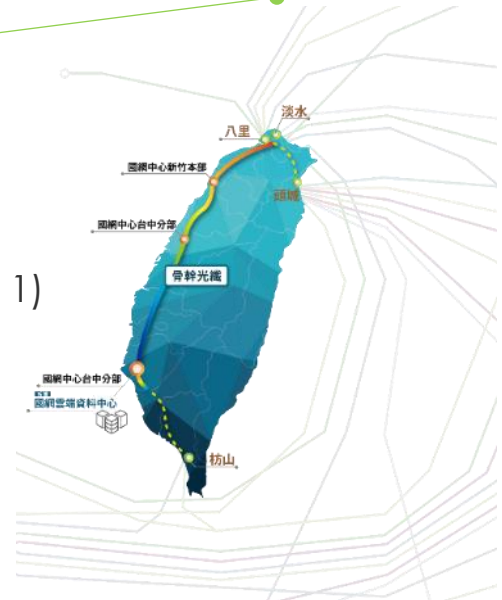
2022
Formosa Open Internet Exchange activated

3.8PF
2023
TAIDE H100

2023
self-build fiber backbone (phase 1) activated

3.4PF
2024
Forerunner 1
is expected to begin services services

2025
Trusted Cloud Environment
launch service



16 PF
2025
Chip-based Innovation Advanced AI HPC

2025
- **NCHC IDC (Tainan) is scheduled for opening**
- self-build fiber backbone (phase 2) activated

Over 200 PF
2026
Strive to expand scientific research computing

2028 **280 PF**
Strive to expand **HPC and Quantum integrated** machine

2029
Greater South Smart-Tech Industrial Ecosystem Project: plans to expand computing power to **480PF**

2029
Great Southern AI Tech. Industrial project:
AI Datacenter Will be built In Sharon, Tainan

NCHC AI Platform

On demand

Computing and storage environment

AI-Big-Data-HPC

Integrated cloud service platform

Customized AI Solution

AI and cloud resources single service portal

台灣杉二號 TAIWANIA 2

台灣杉三號 TAIWANIA 3

Forerunner 1 創進一號

Excellent performance

High convenience and high performance

Containerized computing environment

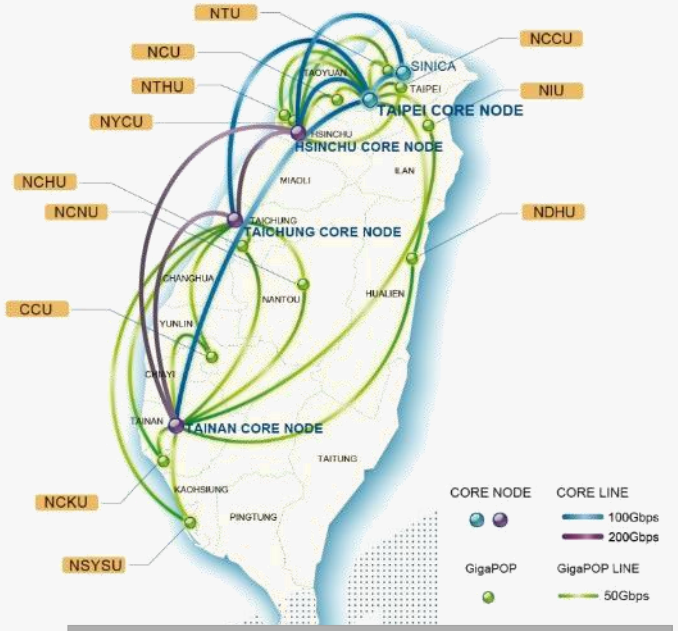
Multi-level security

Network security protection

Research and Education Network

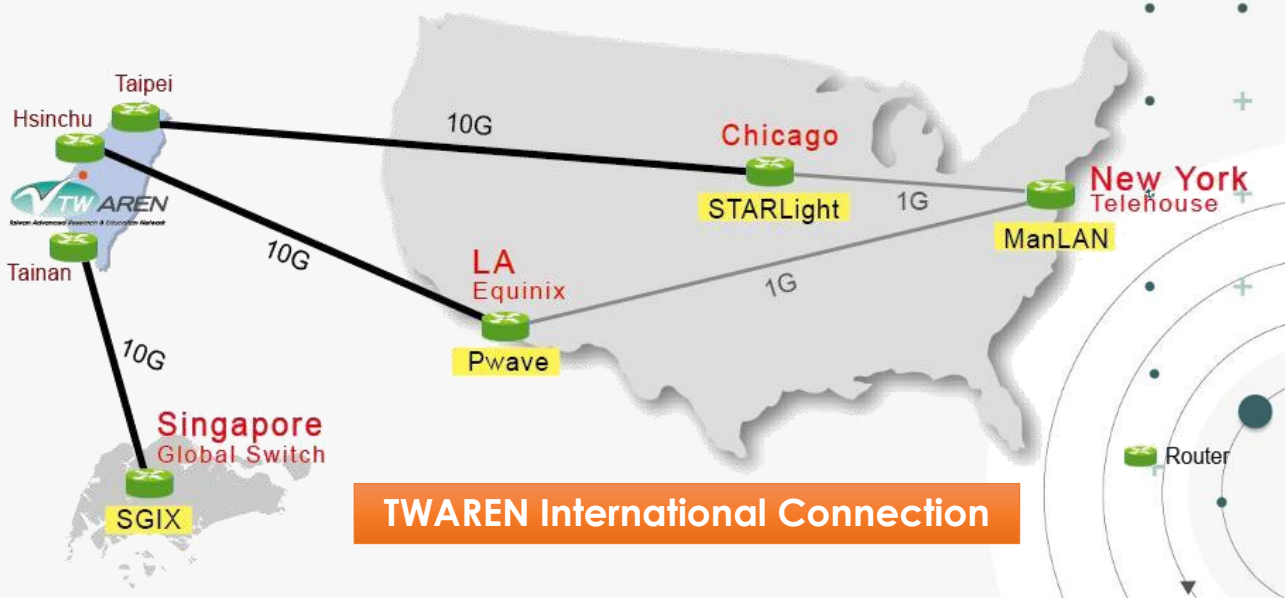
TaiWan Advanced Research and Education Network

- **TWAREN** (Optical, dedicated bandwidth)
  - ✓ 100G Bandwidth
  - ✓ 12 GigaPOPs
  - ✓ 94 universities & research institutes
  - ✓ 500 K. users



TWAREN Domestic Backbone

- ✓Sharing underlying optical network with **TANet** (4000 schools, 4.5 M. users)
- ✓Network Availability: 99.99% ↑
- ✓30 Gbps international links to Los Angeles, Chicago, New York, and Singapore (and peers with other international research and education networks via these four exchange centers)



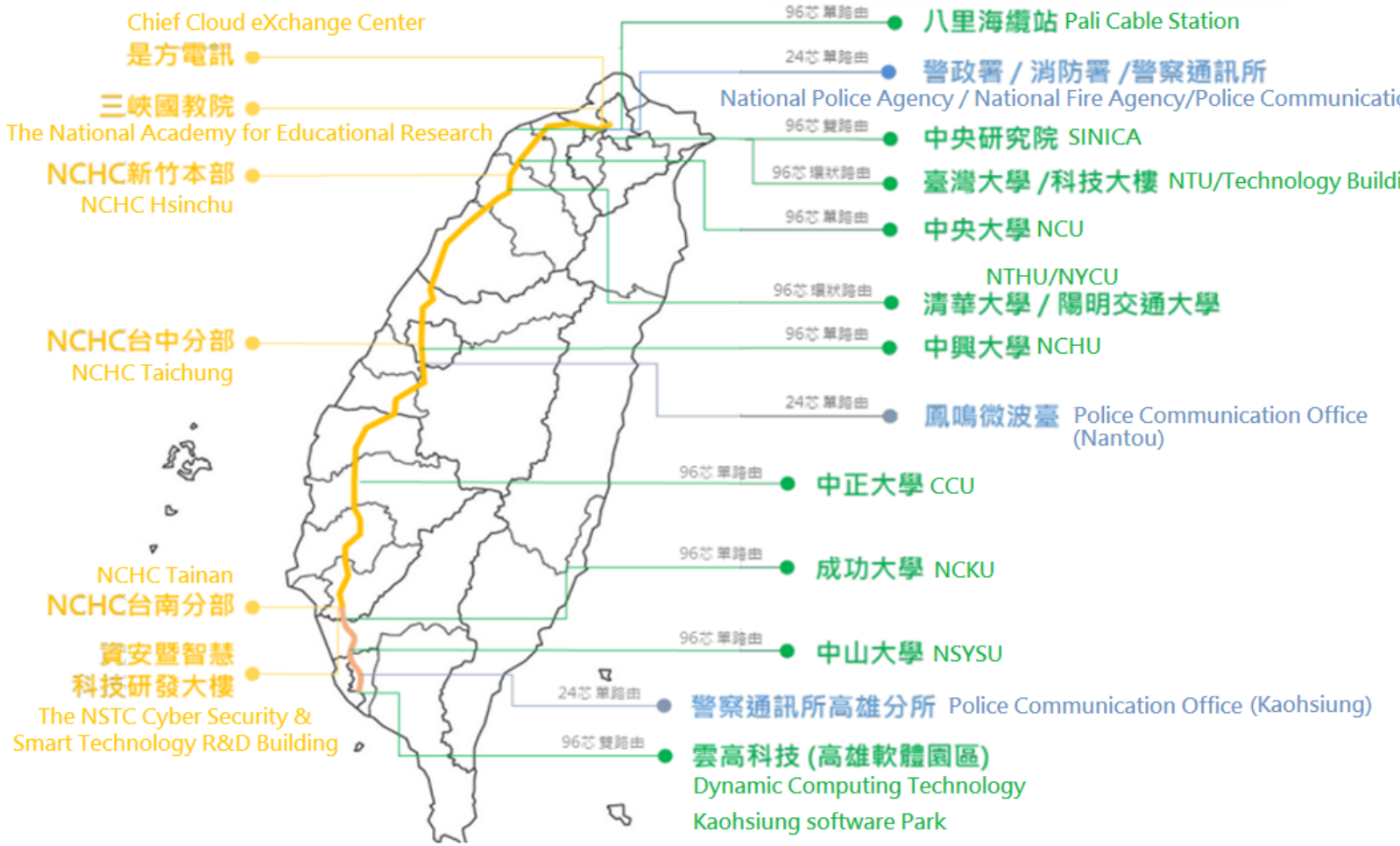
TWAREN International Connection

NCHC Dark Fiber Network Backbone

Resilience Enhancement of cyberinfrastructure of Taiwan

Dark Fiber Built

Future Extension



NCHC LLM Platform

Resilient High-Performance AI Platform

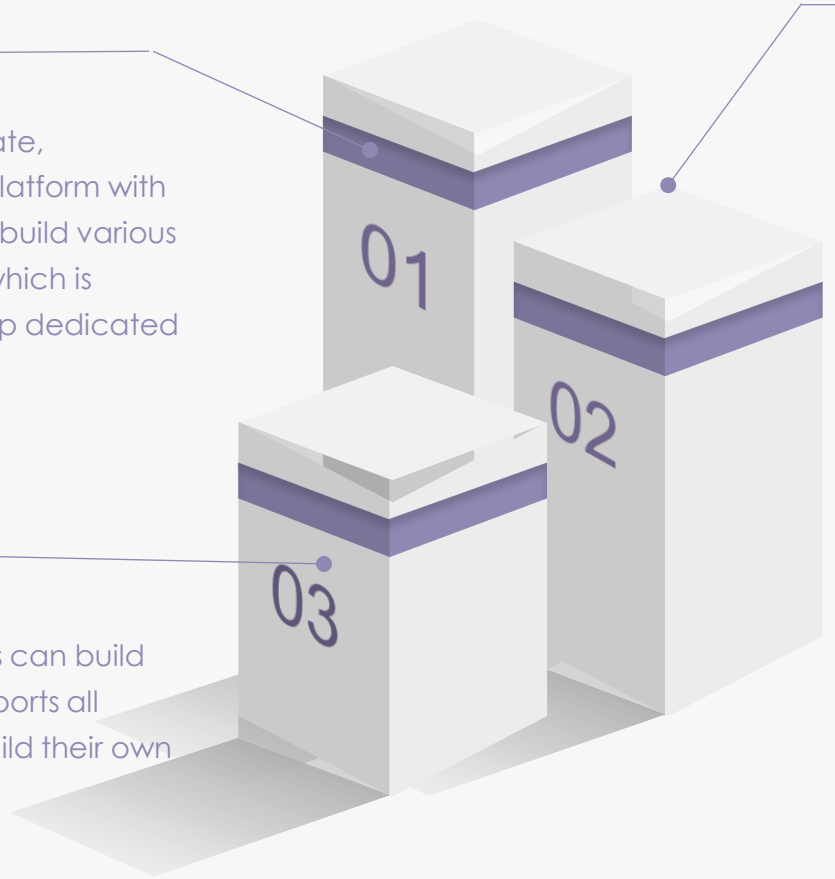
The resilient high-performance AI platform(RHAP) incorporates the TAIDE model, a traditional Chinese LLM based in Taiwan, leveraging the powerful computing resources of NCHC. It offers inference services for LLM and assists customers in training and optimizing their domain data, enabling the creation of customized models and related application services.

All-In-One LLM Inference Service

Provide users to quickly build a private, independent and dedicated LLM platform with GPU environment, where users can build various value-added application services which is suitable for those who want to set up dedicated and private LLM inference services.

LLM Inference API Server

Provide affordable API services, users can build an API service environment that supports all open source language models to build their own LLM API services.



Lightweight LLM Inference Front-end Services

Provides users to build a GPU-free lightweight inference front-end service environment with a built-in chat platform that integrates RAG, allowing users to build their own LLM services with any LLM.

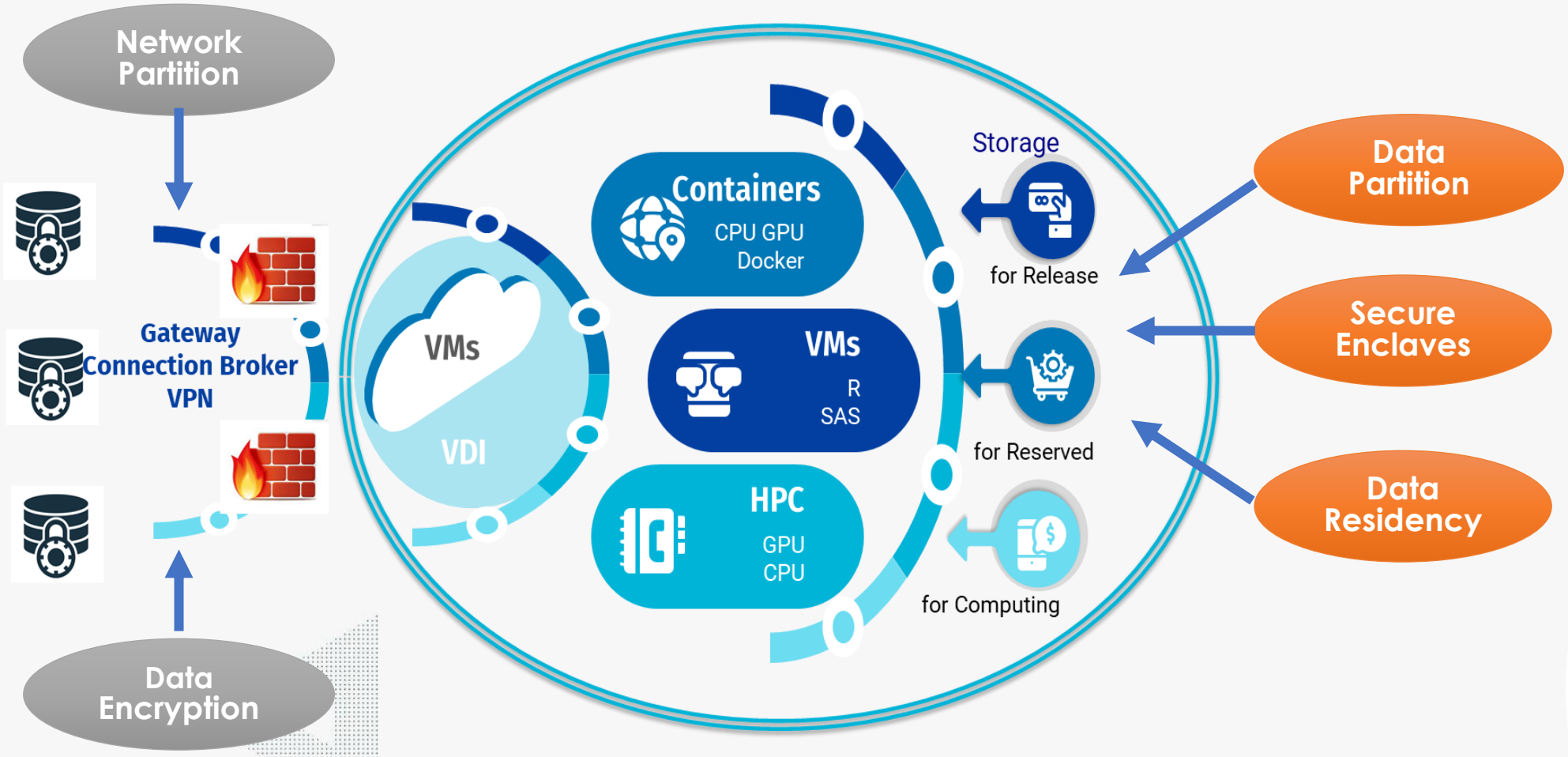
TAIDE(Trustworthy AI Dialogue Engine)

- aimed at developing a generative AI chatbot with Taiwanese characteristics and support for traditional Chinese characters.
- focuses on writing articles, letters, and summaries, as well as providing two-way Chinese-English translation.
- TAIDE will promote generative AI applications and drive development in related industries.

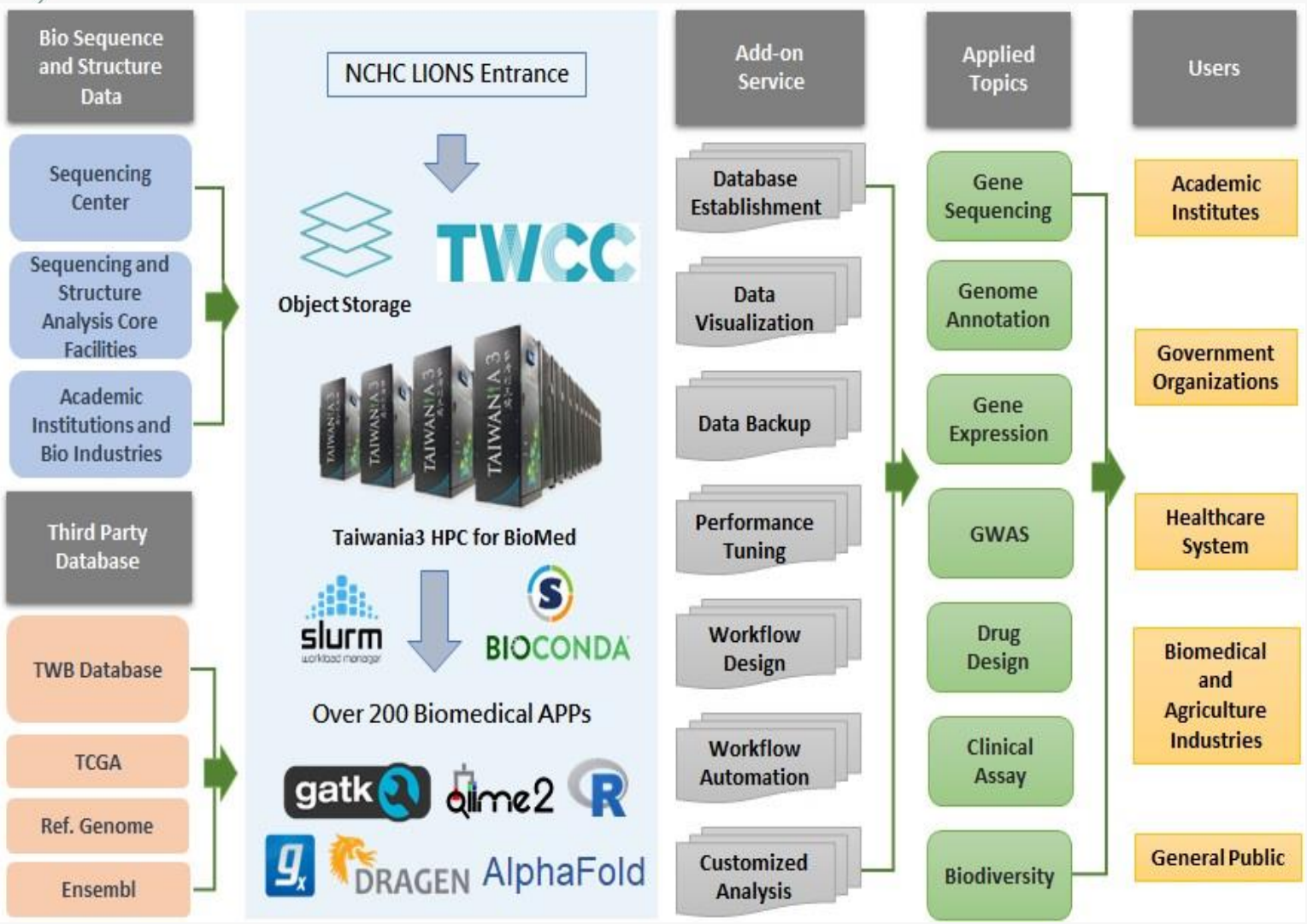
Trusted Data Service Platform and HPC

✓ Establish a trustworthy data cloud analysis infrastructure and promote the safe storage and secondary use of data (2024- 2027)

✓Providing storage and analysis for massive amounts of data in biomedicine, national land governance, defense technology, and scientific computing



Life Science Cloud

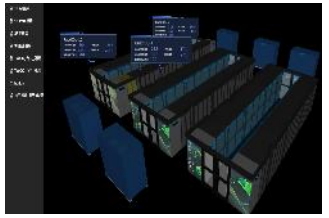


- Based on HPC cluster and cloud server
- Providing libraries, software, and packages for analysis and computing in realm of life science, medicine, and agriculture.
- The platform is optimized to fit characteristics of biological data to improve computing services.

AIOT Application

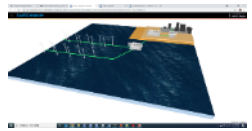
Video analysis: crowd identification, Tainan market epidemic prevention

NCHC Tech v Virus 2.0 Projects with academic

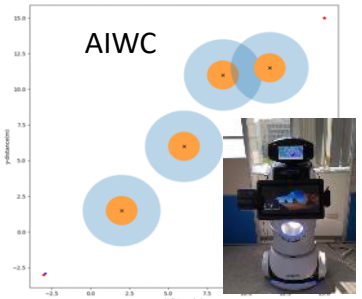


Smart computer room

offshore wind energy



NCKU&CSC– Electric Vehicles



Vascular Heart Rhythm Detection:NCTU

The National Synchrotron Radiation Research Center (NSRRC)

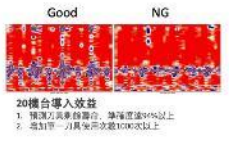
Development

Application

collaboration

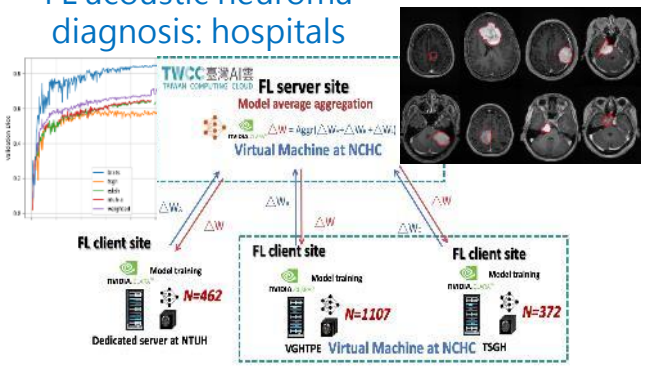
AIOT

Production line AI application ：NTPU



PM2.5tw/TW.JP.TH

FL acoustic neuroma diagnosis: hospitals



R-Pi4 Cloud

Big Data Analytics Competition: Journal of Science and Technology, Ministry of Education, Donghai Univ.

3D GIS

- Apart from typical 2D GIS platform, the new visual experience can be achieved via the WebGL technology from our intelligent 3D-GIS platforms.
- The geospatial platforms fulfill the integration of Big data and AI technology in several aspects e.g. Data acquisition acceleration and data reconstruction, which greatly improve the experience of data visualization, and enhance the quality of governance.

User application

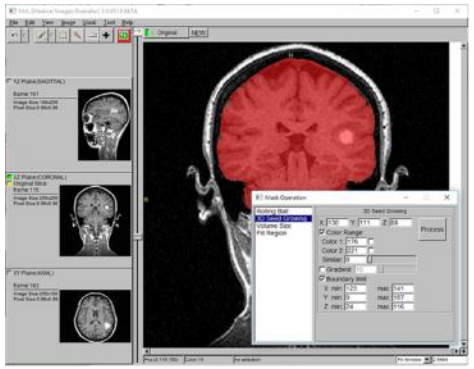
Sea area monitoring

Flooding monitor system

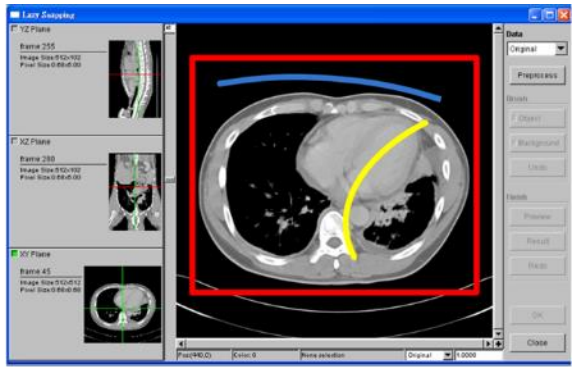
Noise Display map

AR/VR：MiiLs & VVViewer

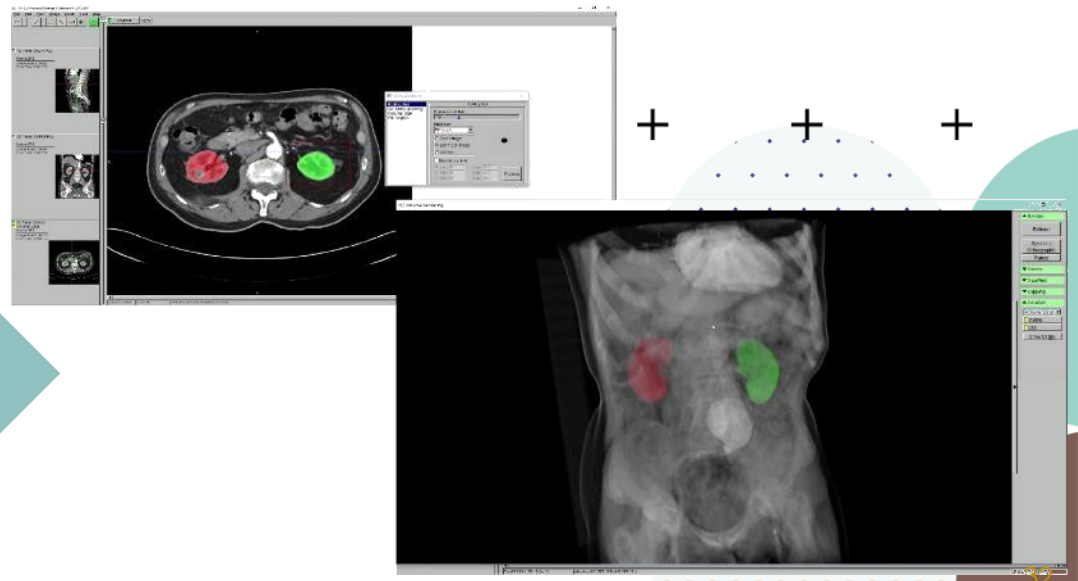
- **A total solution for biomedical image** from processing to visualization and interaction in VR
  - **Miil - Medical image illustrator**
  - **VVViewer - Visualization interactive media lab's VR Viewer**
- Using Miil software, we can import DICOM format image then labeling and segment the image directly. After processing the image, we can export the data and import to VVViewer for visualization and interaction in 3D VR environment.



3D Seed growing



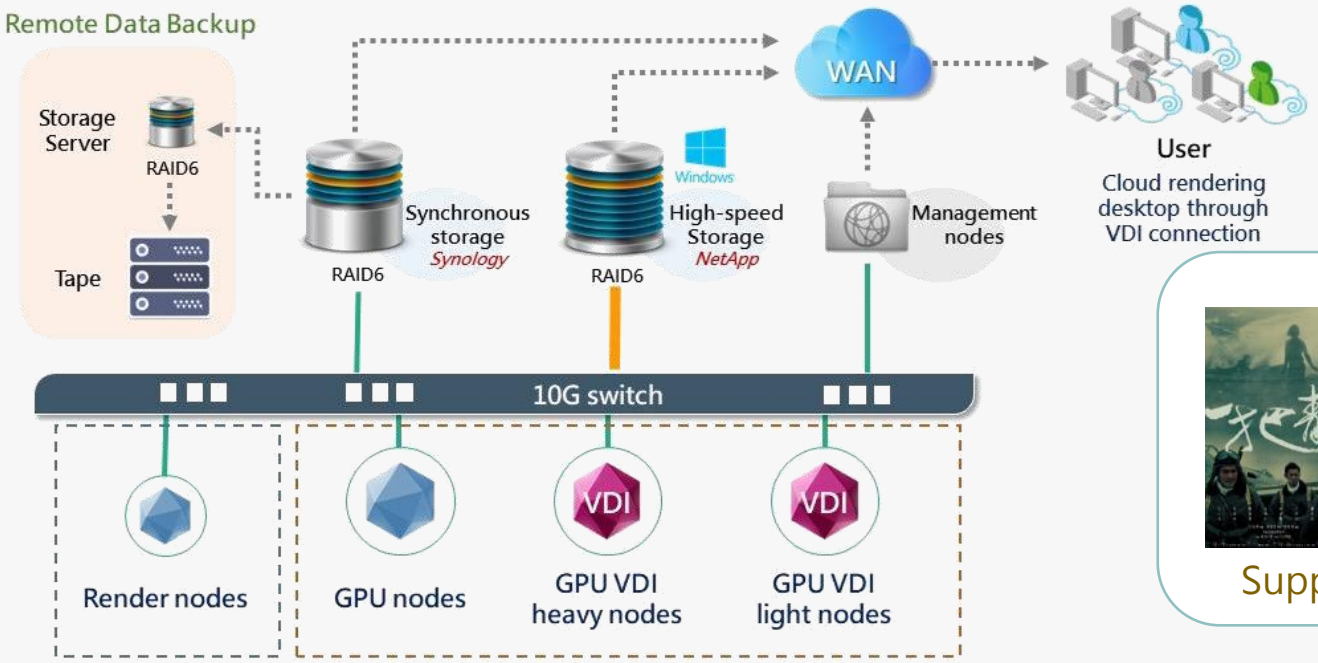
3D Lazy snapping



Render Farm

- Launched in 2011 to promote Taiwanese animation film industry
- Adopt market-leading rendering engines & management software
- Establish **remote desktop using GPU** to speed up film production
- Develop and improve special effect algorithm

Cloud GPU Rendering Platform



NCHC Render Farm Service

Support iconic film productions

"Below Horizon" special effect of fire

Cyber Security

Cyber Defense Exercise Platform

- Cyber Defense Exercise Platform (CDX) is to provide an environment for exercise of information security courses offered in coordination with the government's promotion of information security talent cultivation.
- The platform can be used for long periods of time in coordination with school courses, including the simulation of a real company's network environment with randomly selected vulnerabilities in cyber defense contests, which enhance the hacker defense skills of different sectors.

Malware Knowledge Base

- Malware Knowledge Base simulates system and application vulnerabilities and then monitors the cyber-attacks and the corresponding traffic flow.
- The NCHC established an automated analysis platform for malwares and provides standardized analysis reports for malware behaviors. It deployed a honeynet with over 6,000 IPs on Taiwan's academic network to collect malwares.

International Collaborations

International Involvement

Organization

- **ISC**
  International Supercomputing, EU
- **SC**
  International Supercomputing Conference & Exhibition, US
- **GLIF**
  Global Lambda Integrated Facility, US
- **PRAGMA**
  Pacific Rim Applications and Grid Middleware Assembly

Researches

- **SDSC/UCSD, USA**
- **Northwestern University, USA**
  iCAIR
- **NCSA/UIUC, USA**
  SC/ISC, MOU, advisory board
- **HLRS Stuttgart, Germany**
  SC/ISC
- **AIST, Japan**
  AI platform
- **EU. of Edinburg, UK**
  EU FP7 Fish4Knowledge
- **TACC**
  supercomputing

International Collaborative Partners

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NCHC
National Center for
High-performance Computing
https://www.nchc.org.tw
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Thank you