HPC in Taiwan
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• HPC in Taiwan – rough snapshot
  – HPC in Academia/Government
    • Basic & Applied Research:
      – National Center of High Performance Computer
      – NTU, NCKU ...etc.
      – Academia Sinica
    • Weather & Climate services:
      – Central Weather Bureau
  – HPC in industry
    • Features: PC, servers, mobile devices
    • Applications: Semi-conductor, automotive industry, financial industry, game /VFX industry, weather services.
    • Key issues: production software for design!
Faster, Higher, Stronger in vertical or horizontal?

- **Vertical:**
  - Generate value and impact for budget justification
  - Leverage Scientific, Societal or Economic impact.
  - Compete on productivity, application-driven

- **Horizontal:**
  - Technological Forefront in high end system: TOP500
  - Parallel Computing vs distributed computing
  - Compete on performance, technology-driven

- The vertical usually rules...

- Gaps of HPC between Industry & Academia...(cloud?)
Center Weather Bureau (TW)

- 1+ Peta-flops in 2014
- Fujitsu: PRIMEHPC FX10
  K computer technology
- Weather and Climate Calculation
NCHC: HPC Services

- Open to academic, research, and Industrial users
- Supporting 700+ research projects per year

- ALPS system – most recent supercomputer built in 2011
- $R_{\text{max}}$ 177 TFLOPS sustained, 442.00 MFLOPS/W
  - 25,600 Cores
  - 73,728 GB Memory
  - 1,074 TB Disk

Jun. 2011: Top500 Ranking: No. 42 / Green500 Ranking: No. 25

Advanced Large-scale Parallel Supercluster (ALPS)

NCHC Total Computing Capacity

IBM Cluster 1350 / 19.91TF
HP Superdome2
Computing Usage Statistics

SU Usage From 2012/04 to 2013/03

- Chemistry, 23.9%
- Physics, 21.8%
- Climate, 16.0%
- CFD, 11.3%
- Molecular, 9.2%
- Math, 5.1%
- Others, 5.1%
- Biology, 4.8%
- Solid Mechanics, 3.0%

• SU used in software packages constitutes 28.09% of the total SU.
<table>
<thead>
<tr>
<th>Institute</th>
<th>domain</th>
<th>title</th>
<th>publication</th>
</tr>
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<tbody>
<tr>
<td>NTU</td>
<td>Physics</td>
<td>Pseudoscalar meson in two flavors QCD with the optimal domain-wall fermion</td>
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<td>Aspects of Domain-Wall Fermion on the Lattice</td>
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<td>NCTU</td>
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<td>Simulations of Subsonic Vortex-Shedding Flow Past a 2D Vertical Plate in the Near-Continuum Regime by the Parallelized DSMC Code</td>
<td>Computer Physics Communications</td>
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<td>A Parallel Hybrid Numerical Algorithm for Simulating Gas Flow and Gas Discharge of an Atmospheric-Pressure Plasma Jet</td>
<td>Computer Physics Communications</td>
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<td>NCTU</td>
<td>CFD</td>
<td>Large-Scale Simulations on Multiple Graphics Processing Units (GPUs) for the Direct Simulation Monte Carlo Method</td>
<td>Journal of Computational Physics</td>
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<td>NTHU</td>
<td>CFD</td>
<td>Large eddy simulations of turbulent Couette_Poiseuille and Couette Flows inside a square duct</td>
<td>J. Fluid Mech., Vol. 702, pp. 89_101</td>
</tr>
<tr>
<td>NTHU</td>
<td>CFD</td>
<td>Numerically Investigated Effects of Different Dean Number and Pitch Size on Flow and Heat Transfer Characteristics in a Helically Coil-Tube Heat Exchanger</td>
<td>Applied Thermal Engineering</td>
</tr>
<tr>
<td>NTHU</td>
<td>MD</td>
<td>Thermophysical characteristics of Ethylene Glycol-based Copper nanofluids Using Nonequilibrium and Equilibrium Methods</td>
<td>International Journal of Thermal Sciences</td>
</tr>
<tr>
<td>NTU</td>
<td>Mechanics</td>
<td>Persuasive feedback model for inducing energy conservation behaviors of building us based on interaction with a virtual object</td>
<td>Energy and Buildings</td>
</tr>
<tr>
<td>NTU</td>
<td>Mechanics</td>
<td>A micromechanics study of competing mechanisms for creep fracture of zirconium diboride polycrystals</td>
<td>Journal of the European Ceramic Society</td>
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</table>
Research and Education Network

• Providing research network, education network (TANet), and optical lightpath services with 20Gbps backbone

• Peering with 35 IPv4 and 24 IPv6 networks worldwide with 5Gbps connection

• Network availability rate up to 99.991%

• Dynamic circuit provisioning enabled
Storage Services

Storage Capacity

• Three-site, 3-tier backup
• Disk 1.13 PB/Tape 1.62 PB
• Supports 18 projects from academia and research institutes
• Deploys disk and tape facilities in Hsinchu, Taichung, and Tainan; Interconnected via TWAREN and Storage Area Network (SAN)
Self-built Cluster Computers

2003
Formosa 1
• The first PC Cluster for online service

2005
Formosa 2
• The first 64-bit PC Cluster for online service
• 64-bit Dual-Core CPU and InfiniBand

2005
Formosa 3
• Cloud Cluster Virtualization and Green Computing
• Cloud IaaS Service

2010
Formosa 4
• Cloud Cluster
• GPU accelerator

2011
Formosa 4
• 2011 TOP500 #234
• 2011 Green500 #37

2011
Formosa 4
• 2011 TOP500 #234
• 2011 Green500 #37

2011
Formosa 4
• Cloud Cluster
• Big memory
• Hybrid-Computing Platform

2012
Formosa 5
• Cloud Cluster
• Big memory
• Hybrid-Computing Platform

2012
Formosa 5
• 2011 TOP500 #232
• 2011 Green500 #62
Launch the fastest **render farm** in Taiwan for public access in 2011

Develop **render scheduler** to increase rendering performance
# S&T Software and Databases

- Provides 40 different software packages and databases for HPC

<table>
<thead>
<tr>
<th>Type</th>
<th>Software</th>
</tr>
</thead>
</table>
| **Math** | 1. Math. Tools: Matlab, IDL  
| **Engineering application** | 1. Multibody Dynamics/Mechanism: MSC Adams  
2. Semiconductor: Sentaurus TCAD  
4. Pre-& Post-Processor: ANSYS ICEMCFD, FIELDVIEW, MSC. Patran, Tecplot  
5. CFD: ANSYS CFX, CFD-ACE+, Fluent  
6. MEMS: CoventorWare, IntelliSuite  
7. Electro-Magnetics: Ansoft, CST STUDIO SUITE |
| **Science software & database** | 1. Life Science: GCG, IMARIS  
2. Chemistry, physics and bioscience applications: ADF, Crystal, Amber, Discovery Studio, Gauss View, Materials Studio, Schrodinger package, Sybyl, Pandat ...  
3. Chemistry database: CSD, DiscoveryGate |
| **Render farm** | 1. Render farm: Blender, MR Standalone, Maya, Vray for Maya, Qube |
Scalable Molecular Dynamics Computing

- An scalable MD (Molecular Dynamics) package with very efficient parallel algorithm for new hybrid CPU/GPU cluster

Hybrid platforms:
1. Single CPU
2. Singe GPU
3. CPU cluster
4. Multi-GPU cluster

Potential Library:
1. Lennard-Jones potential
2. Tight-binding potential
3. Coarse-grained potential
4. LAMMPS potential
5. GROMACK potential
6. AMBER potential
7. CHARMM potential
8. NAMD potential
9. ... etc. (User customized)
Visualization and Augmented Reality

⚠️ Geo-informatics Platform
We build an interactive large terrain navigation with GIS database for
- Disaster management.
- Strategic plan for national spatial development.

🏠 Bio-images Archiving
Visualization on Cloud:
- Visualization tools on cloud for everyone.
- Archive of 3D bio-medical images with tools for intelligence analytics.

👨‍💻 iHPC
Using GPU for simulation and visualization:
- Real-time simulation and real-time visualization together.
- With GPU technology and Augmented Reality.
3D FlyCircuit Database Cloud Services

• The world’s first interactive 3D brain image database [http://www.flycircuit.tw/](http://www.flycircuit.tw/)
  – Allows researchers to study the brain’s neurotransmission pathways in amazing detail and, as a result, gives them a deeper understanding of the complex functions of the brain. (collaboration with Brain Research Center at NTHU)

• It services **79 countries and 877 cities** around the world.

Dr. James D. Watson, “Father of the DNA Double Helix,” visited the NCHC (2010.05)
Real Time High Resolution Image Monitoring System

Video Streaming

• Applied to undersea high resolution monitoring
• The world’s only long-term coral reef observation network
• Real time ecology monitoring near the southern Taiwan nuclear power plant

Real time images of coral reefs around the sea water inlet of the Kenting nuclear power plant
Disaster Reduction Cloud

- Implementation of Data-Model-Display-Management (DM²) scenario-based workflow
- Big Data integration, analytics and visualization for disaster information management and cloud service
- Real-time water level monitoring network.
- 3D GIS cloud service
Open Source Software Development

- Middleware developed and provided under open source free software licenses
- DRBL and Clonezilla: Over 7.9 million downloads in 80 countries worldwide.
  Multiple language (11) versions: Catalan, German, English, French, Italian, Portuguese, Russian, Spanish, Japanese, Simplified Chinese, Traditional Chinese.
# Software Awards List

<table>
<thead>
<tr>
<th>Year</th>
<th>Award Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>DRBL won 1st place in Les Trophees du Libre</td>
</tr>
<tr>
<td>2008</td>
<td>DRBL/Clonezilla won Award for Outstanding Contributions in Science and Technology NARL in 2008</td>
</tr>
<tr>
<td>2008</td>
<td>DRBL/Clonezilla won Award for Outstanding Contributions in Science and Technology by Executive Yuan in 2008</td>
</tr>
<tr>
<td>2008</td>
<td>Tux2live won the sixth Linux gold penguin prize</td>
</tr>
<tr>
<td>2009</td>
<td>Tux2live won the Awards of Excellence and Honors in the Open Source Innovative Application Development Contest</td>
</tr>
<tr>
<td>2010</td>
<td>Clonezilla was chosen as Project of the Month on Sourceforge</td>
</tr>
<tr>
<td>2010</td>
<td>Crawlzilla won the 1st place in the Open Source Innovative Application Development Contest</td>
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<tr>
<td>2011</td>
<td>Crawlzilla won Award for Outstanding Contributions in Science and Technology NARL</td>
</tr>
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<td>2011</td>
<td>Clonezilla was Selected as One of the Best Free Software of 2011 by PC Magazine. Clonezilla was rated by lifehacker as the Best Disk Cloning App for Linux.</td>
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<tr>
<td>2012</td>
<td>Clonezilla was selected as one of the best free software of 2012 by PC Magazine</td>
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</table>
• **Cluster Auto Installation (CAI)**
  
  – a low-cost system package for HPC Cluster
  
  – provides all the tools needed to run, and manage an HPC cluster in one easy to install package

• **Cluster Monitoring System**
  
  – web-based system level, hardware level, job queue monitoring interface
  
  – Intelligent Platform Management Interface (IPMI) standard for remote monitoring and reboot
Established TWMAN framework for cyber security and malware behavior analysis

- Collected more than 150,000+ malware samples in Taiwan
- Design large-scale Honeynet platform and develop distributed big data for analysis and research
- Design the Malware behavior knowledge database and build CSIRT in Taiwan
- Established relationships with security organizations worldwide
Future Internet SDN Testbed

- Setup a national wide SDN Testbed based on OpenFlow, and connect it with iGENI@US and JGN-X@JP
- Develop tools for large-scale SDN network management, including:
  - Inter-domain topology auto-discovery
  - Inter-domain real-time flow monitoring
- Demonstrations are made at GEC, GLIF and SC conferences