HPC-related R&D in 863 Program

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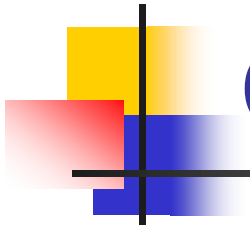


Outline

- The 863 key project on HPC and Grid
- Status and Next 5 years

863 efforts on HPC and Grid

- **"High performance computer and core software"**
  - **4-year effort, May 2002 to Dec. 2005**
  - **100 million Yuan funding from the MOST**
  - **More than 2X associated funds from local government, application organizations, and industry**
  - **Outcomes: China National Grid (CNGrid)**
- **"High productivity Computer and Grid Service Environment"**
  - **Period: 2006-2010**
  - **940 million Yuan from the MOST and more matching investment from other sources**

Major R&D activities

- HPC development
- Grid software development
- CNGrid development
- Grid and HPC applications

1. HPC development

- Two phase development
  - First phase: two 100TFlops machines for
    - Dawning 5000A for SSC
    - Lenovo DeepComp 7000 for CASSC
  - Second phase: three 1000Tflops machines for
    - Tianjin Supercomputing Center (Binhai New Zoon)
    - South China Supercomputing Center (Shenzhen)
    - Shandong Supercomputing Center (Jinan)

Dawning 5000A

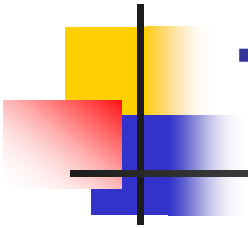
- Constellation based on AMD multicore processors
- Low power CPU and high density blade design
- High performance InfiniBand switch
- 233.472TFlops peak performance, 180.6TFlops Linpack performance
- The 10th in TOP500 in Nov. 2008, the fastest machine outside USA

Lenovo DeepComp 7000

- Hybrid cluster architecture using Intel multicore processors
- Two sets of interconnect
  - InInfiniBand
  - Gb Ethernet
- SAN connection between I/O nodes and disk array
- 145.965TFlops peak performance
- 106.5 Tflops Linpack performance
- The 19th in TOP500 in Nov. 2008

Tianhe I

- Hybrid system
  - General purpose unit--Intel 4-core processors
  - Acceleration unit--AMD GPUs
  - Service unit—Intel 4-core processors
- 1206TFlops peak
  - General purpose: 200+TF
  - GPU: 900+TF
- 560 TFlops Linpack performance
  - Reasonable efficiency for a hybrid system
- 1.6MW
- Announced on Oct. 29, 2009

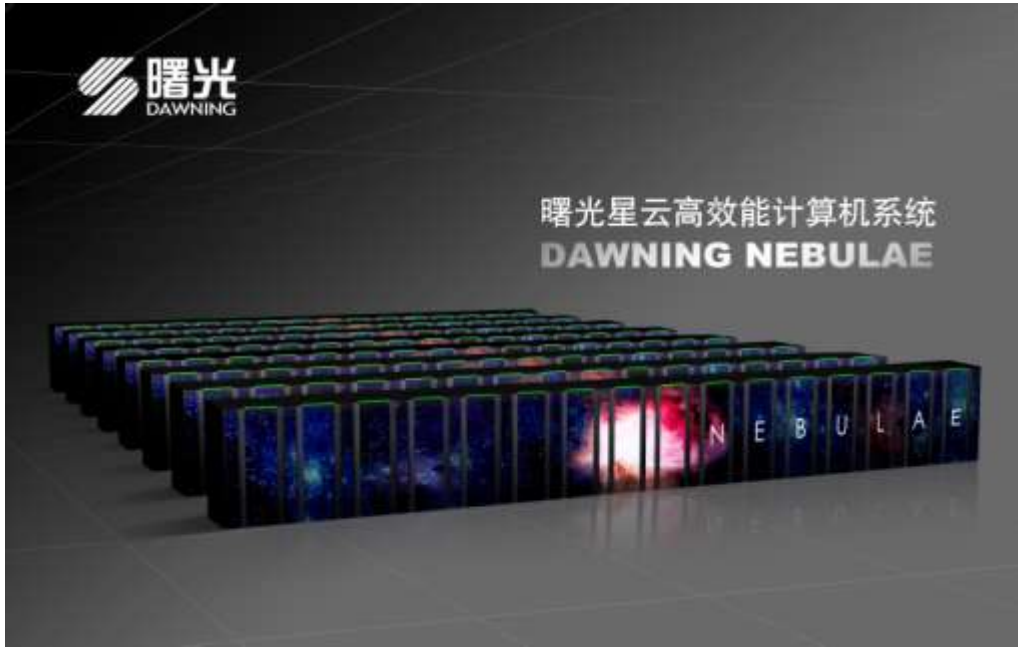


Tianhe I

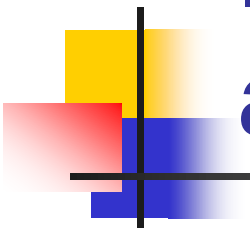
- High speed network chips developed
  - 2x QDR InfiniBand
- Coordination of heterogeneous components of the system
- Programming support for the heterogeneous system
- The second phase of Tianhe (Tianhe II?) will be completed by the end of this year
  - Adding more general purpose computing power (1PF)
  - Adding small amount of domestic processor
  - Replacing the AMD GPUs with nVIDIA's new Fermi GPUs (1.3PF)

Dawning 6000

- Hybrid system
  - Service unit (Nebula)
    - 9600 Inter 6-core Westmere processor
    - 4800 nVidia Fermi GPGPU
    - 3PF peak performance
    - 1.27 Linpack performance
    - About 2.6 MW
  - Computing unit
    - Implemented with Loonson 3B processor
    - Complete in 2011

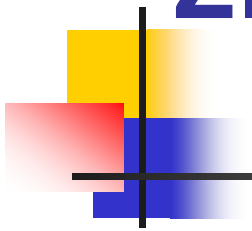


Issues about hybrid architectures



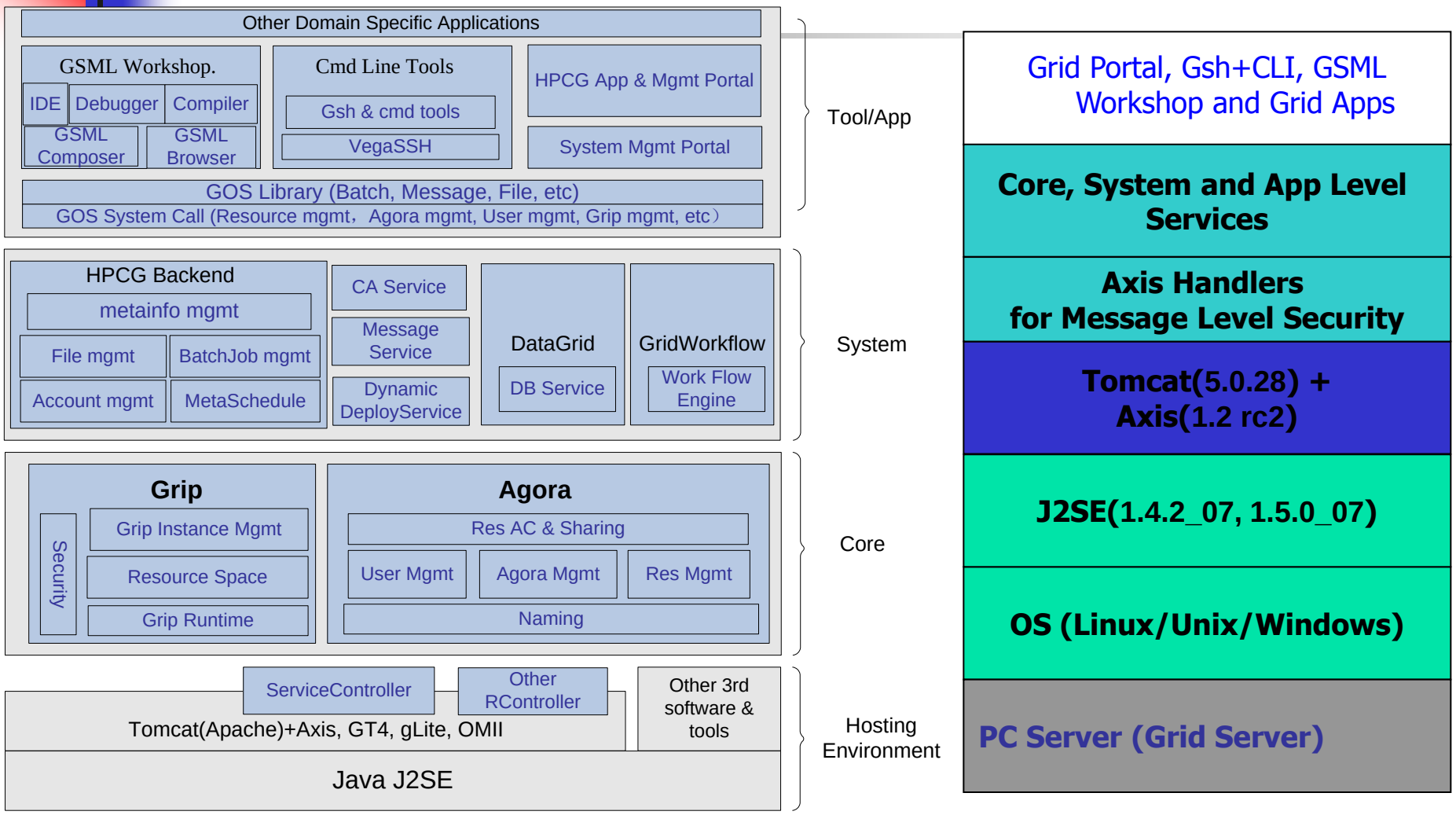
- How to effectively use heterogeneous parts of the system?
  - Applications which can effectively use the accelerators are still limited
- Difficulty in programming the hybrid system
  - Need programming support for the hybrid systems

2. Grid software development



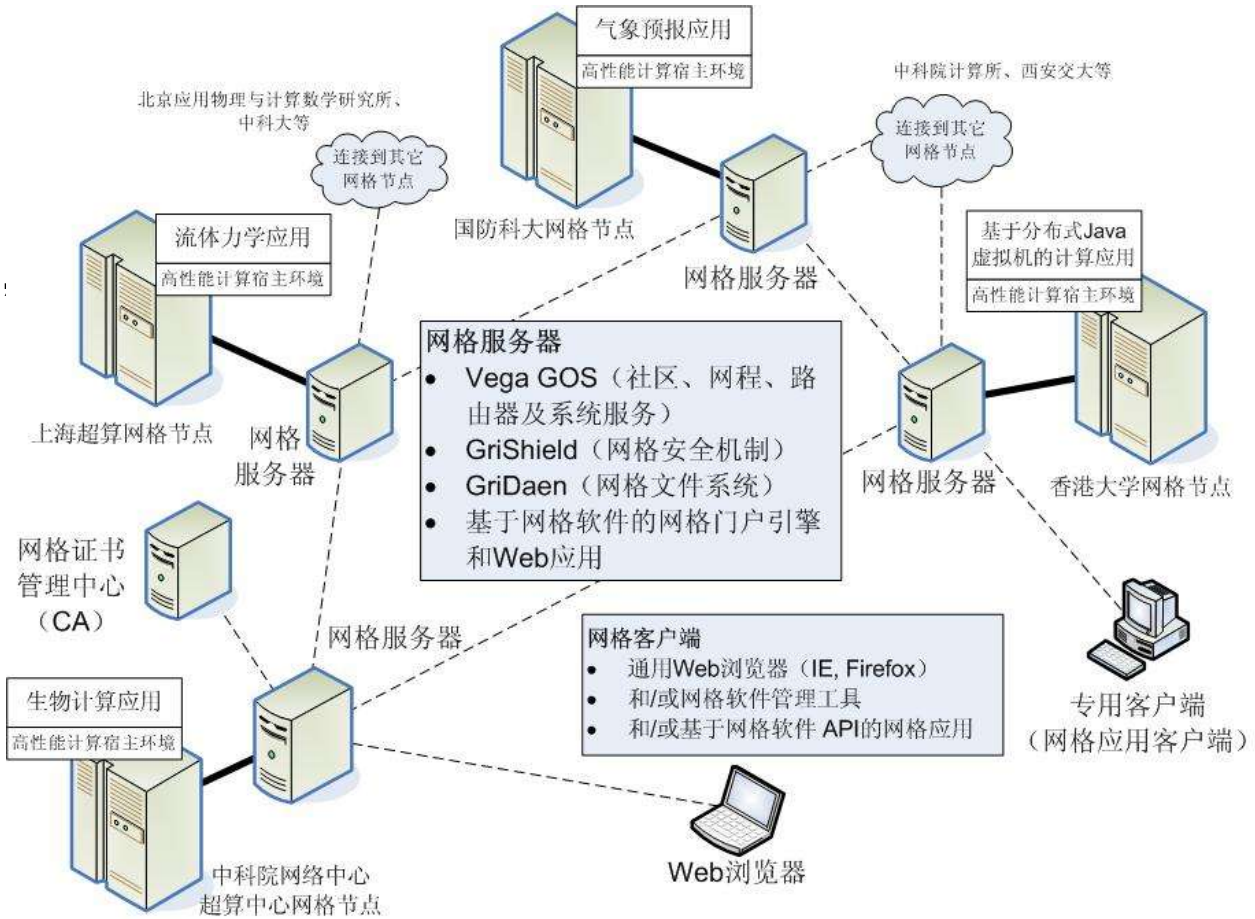
- **Goal**
  - **Developing system level software for supporting grid environment operation and grid applications**
  - **Pursuing technological innovation**
  - **Emphasizing maturity and robustness of the software**

CNGrid GOS Architecture



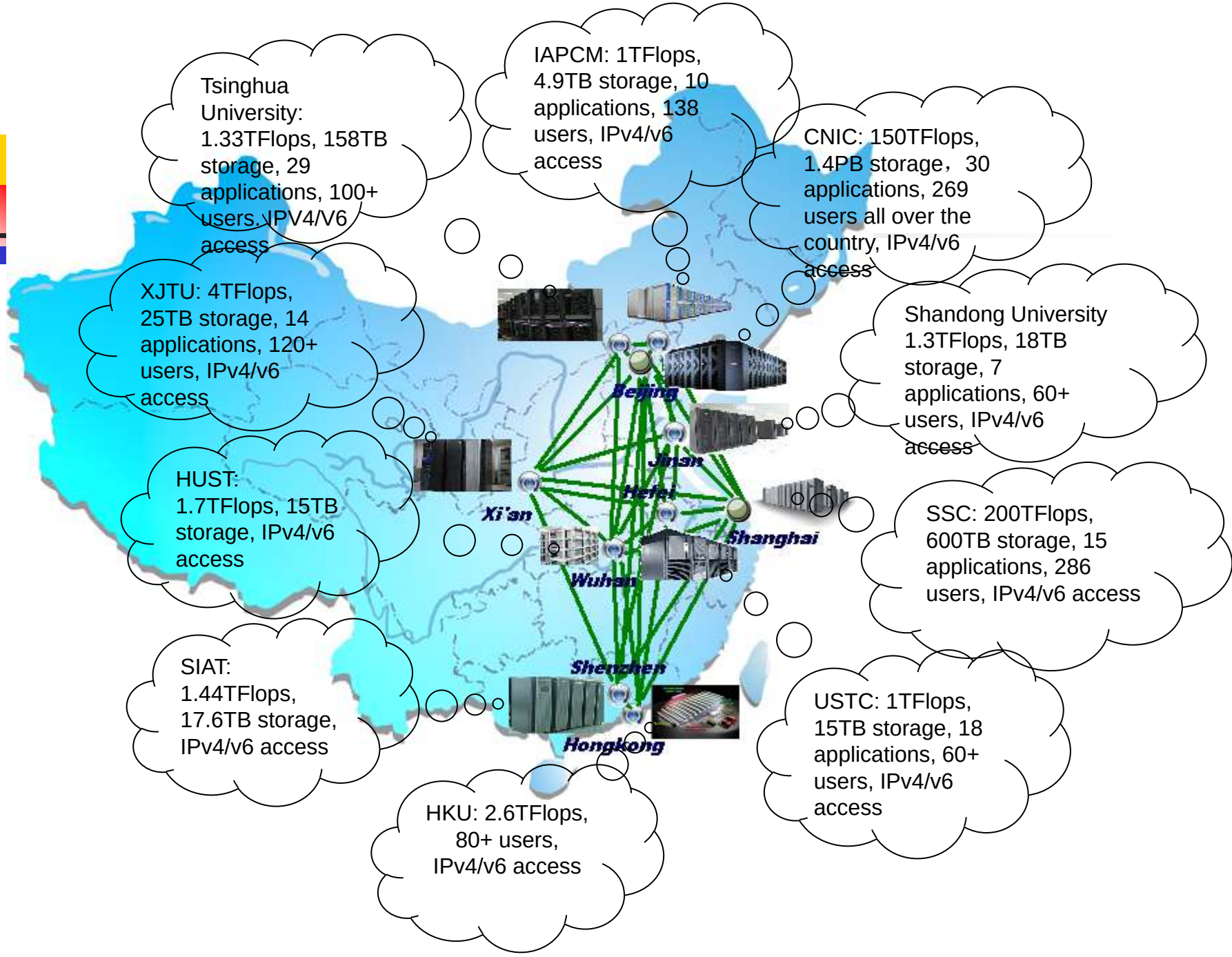
CNGrid GOS deployment

- CNGrid GOS deployed on 10 sites and some application Grids
- Support heterogeneous HPCs: Galaxy, Dawning, DeepComp
- Support multiple platforms
  Unix, Linux, Windows
- Using public network connection, enable only HTTP port
- Flexible client
  - Web browser
  - Special client
  - GSML client



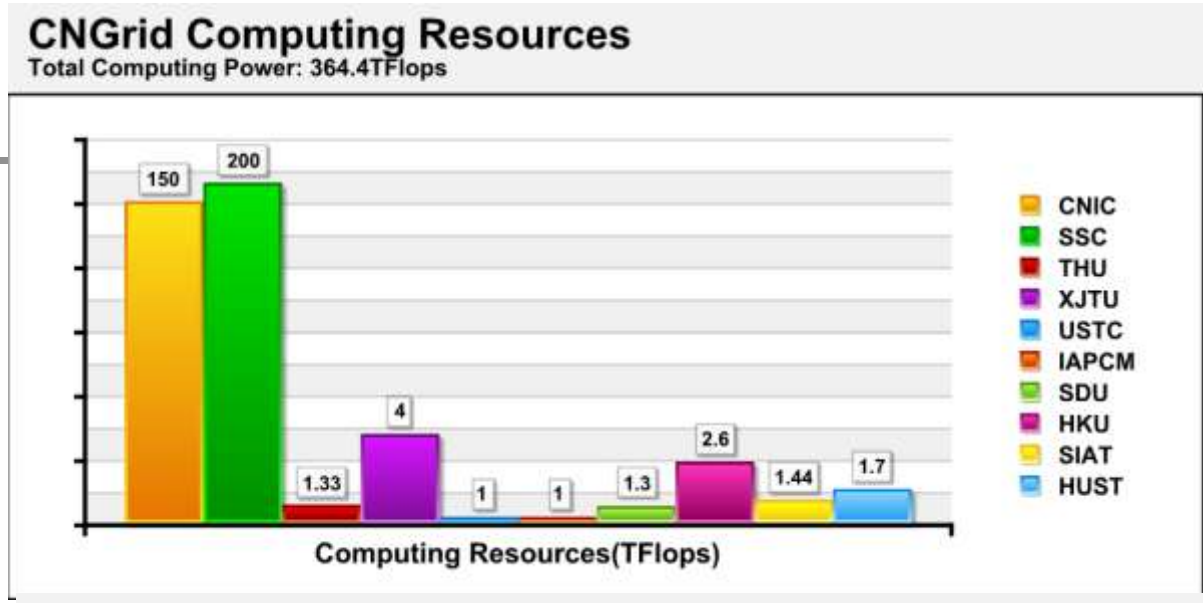
3. CNGrid development

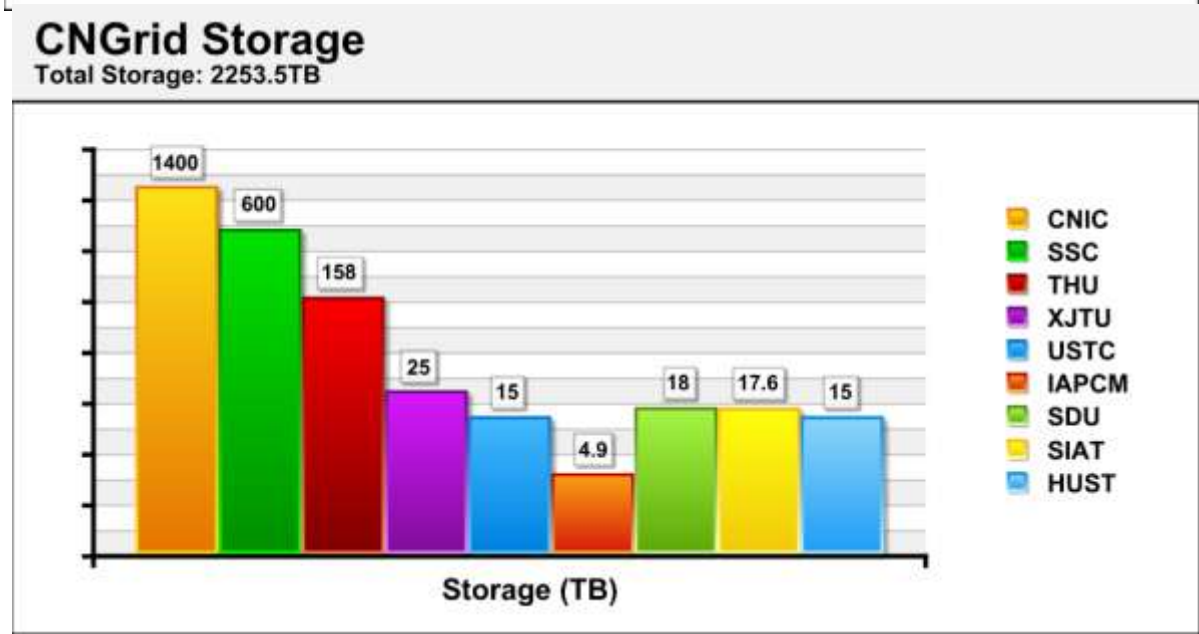
- Ten sites
  - CNIC, CAS (Beijing, major site)
  - Shanghai Supercomputer Center (Shanghai, major site)
  - Tsinghua University (Beijing)
  - Institute of Applied Physics and Computational Mathematics (Beijing)
  - University of Science and Technology of China (Hefei, Anhui)
  - Xi'an Jiaotong University (Xi'an, Shaanxi)
  - Shenzhen Institute of Advanced Technology (Shenzhen, Guangdong)
  - University of Hong Kong (Hong Kong)
  - Shandong University (Jinan, Shandong)
  - Huazhong University of Science and Technology (Wuhan, Hubei)
- The CNGrid Operation Center (based on CNIC, CAS)
- Three PF sites will be integrated into CNGrid


Tsinghua University: 1.33TFlops, 158TB storage, 29 applications, 100+ users, IPV4/V6 access
IAPCM: 1TFlops, 4.9TB storage, 10 applications, 138 users, IPv4/v6 access
CNIC: 150TFlops, 1.4PB storage，30 applications, 269 users all over the country, IPv4/v6 access
XJTU: 4TFlops, 25TB storage, 14 applications, 120+ users, IPv4/v6 access
Shandong University 1.3TFlops, 18TB storage, 7 applications, 60+ users, IPv4/v6 access
HUST: 1.7TFlops, 15TB storage, IPv4/v6 access
SSC: 200TFlops, 600TB storage, 15 applications, 286 users, IPv4/v6 access
SIAT: 1.44TFlops, 17.6TB storage, IPv4/v6 access
USTC: 1TFlops, 15TB storage, 18 applications, 60+ users, IPv4/v6 access
HKU: 2.6TFlops, 80+ users, IPv4/v6 access
Beijing
Jinan
Hefei
Xi'an
Shanghai
Wuhan
Shenzhen
Hongkong

CNGrid: resources

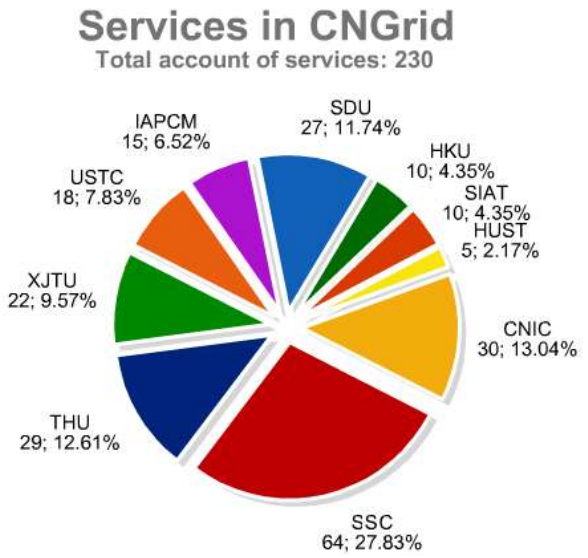
- 10 sites
- 380TFlops
- 2200TB storage

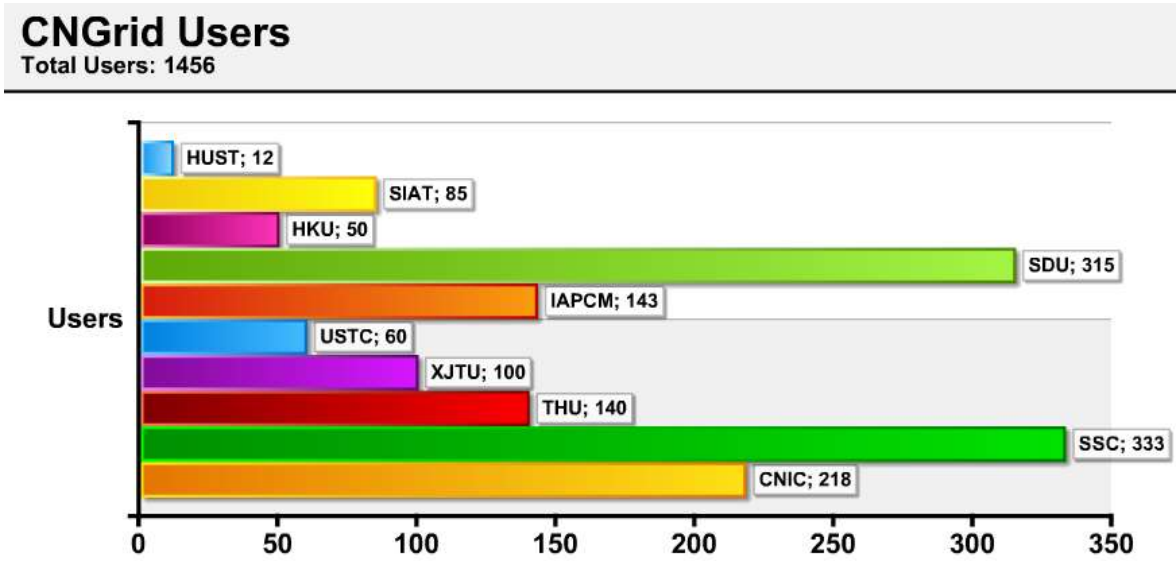




CNGrid：services and users

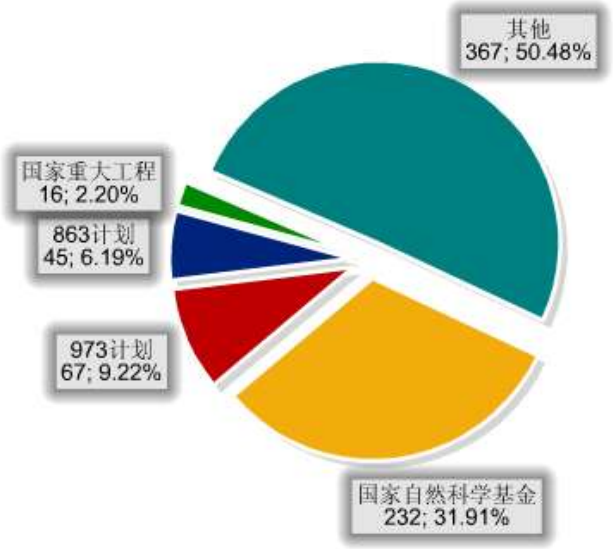
- 230 services
- >1400 users
  - China commercial Aircraft Corp
  - Bao Steel
  - automobile
  - institutes of CAS
  - universities
  - ……

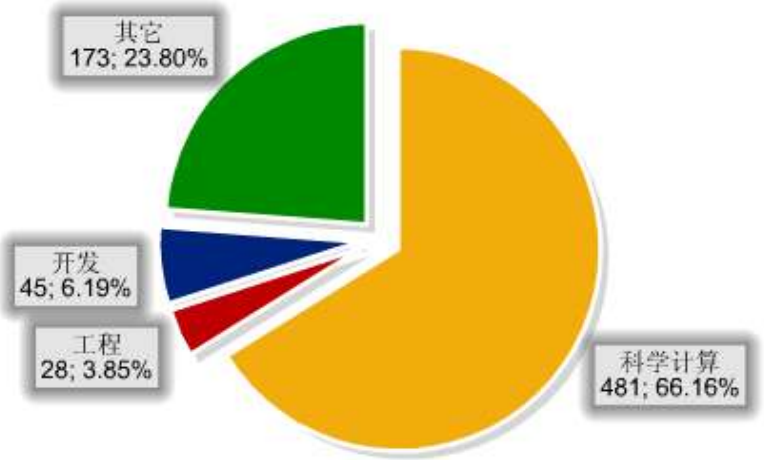




CNGrid：applications

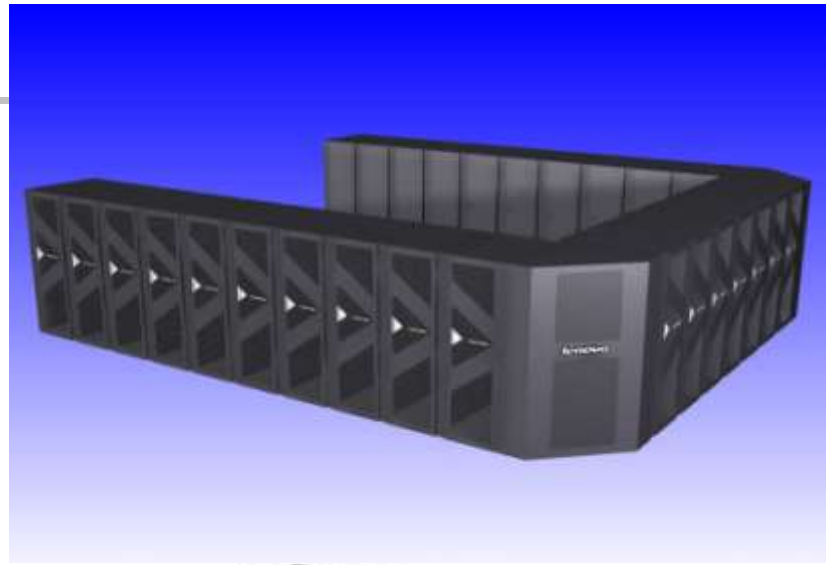
- **Supporting >700 projects**
  - **973, 863, NSFC, CAS Innovative, and Engineering projects**





CAS Supercomputing Center (SCCAS)

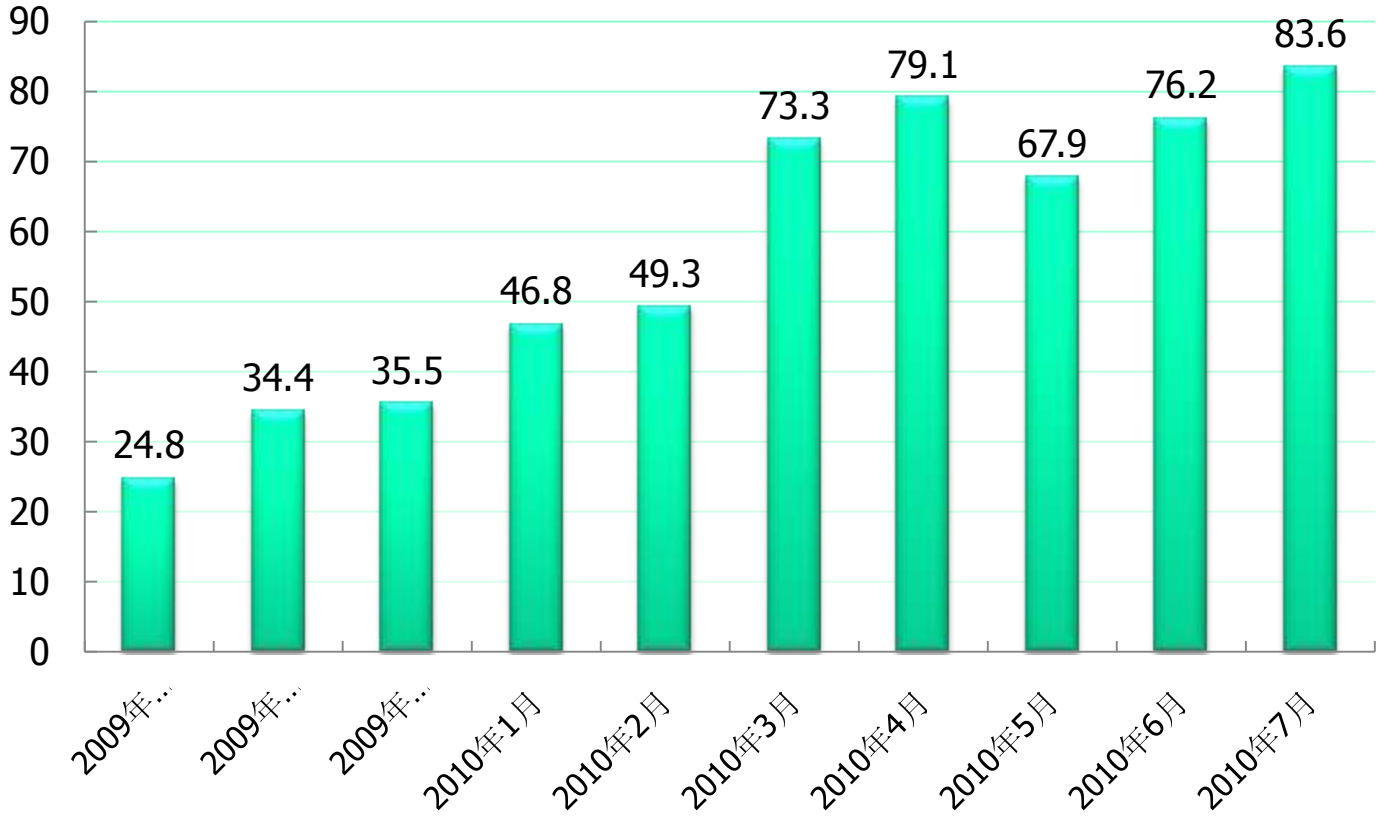
- Established at CNIC CAS in 1996
- Currently installation
  - Lenovo DeepComp 7000
- Applications
  - 200+ registered users
  - Supporting more than 120 important projects
  - A number of important achievement obtained



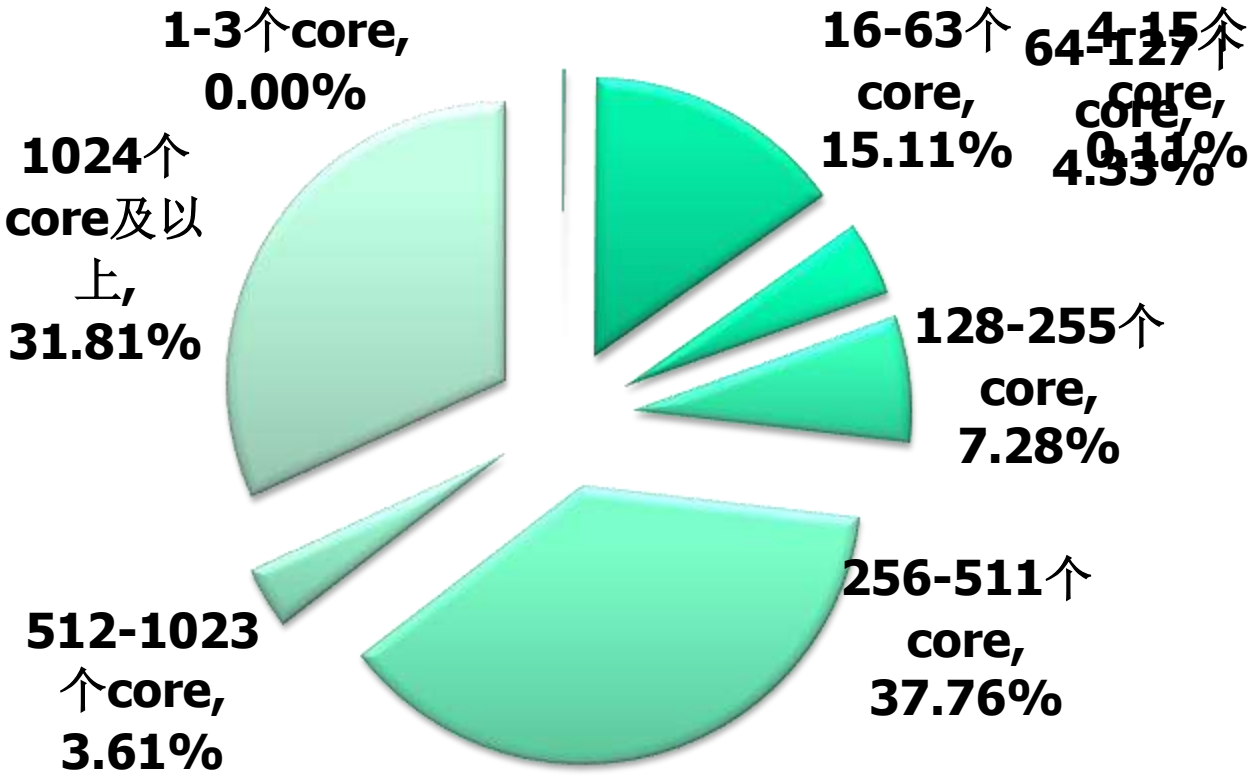
Shanghai Supercomputing Center (SSC)

- Established by Shanghai city government in 2000
- Currently installation
  - Dawning 5000A
- 300+ users

Utilization (SSC)

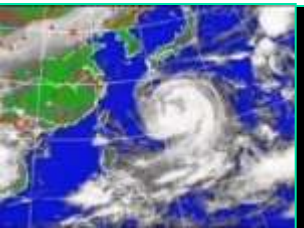
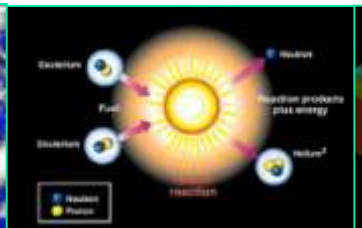
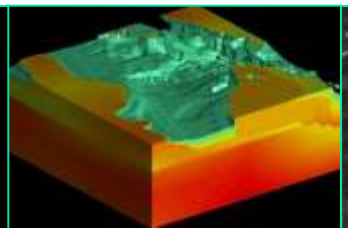


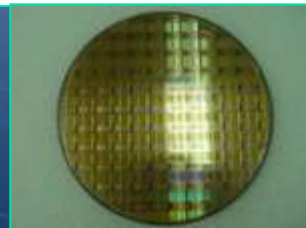
Application scale (SSC)



4: Grid and HPC applications

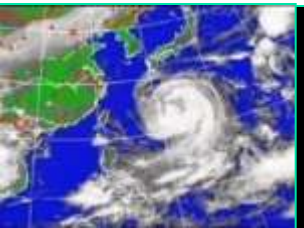
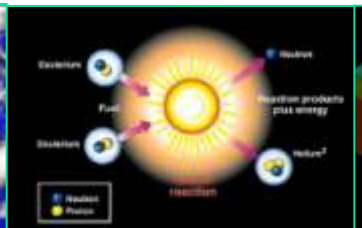
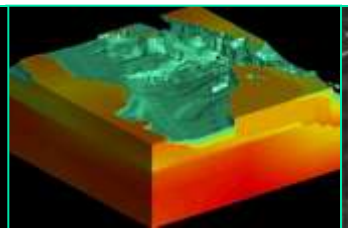
- Developing productive HPC and Grid applications
- Verification of the technologies
- Applications from some selected areas
  - Resource and Environment
  - Research
  - Services
  - Manufacturing

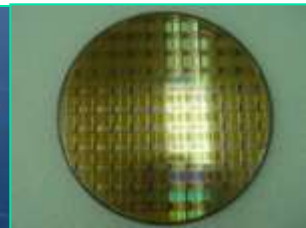




Grid applications

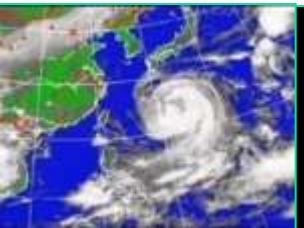
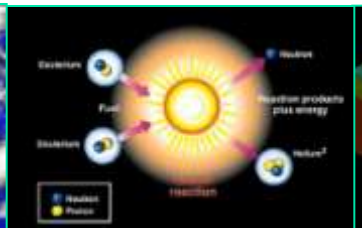
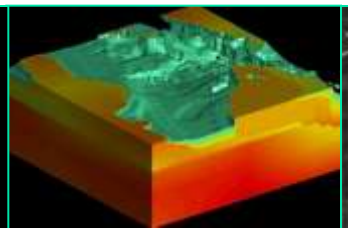
- Drug Discovery
- Weather forecasting
- Scientific data Grid and its application in research
- Water resource Information system
- Grid-enabled railway freight Information system
- Grid for Chinese medicine database applications
- HPC and Grid for Aerospace Industry (AviGrid)
- National forestry project planning, monitoring and evaluation

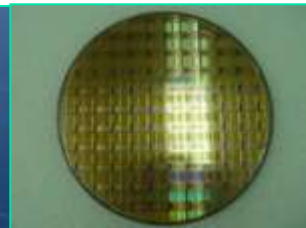




HPC applications

- Computational chemistry
- Computational Astronomy
- Parallel program for large fluid machinery design
- Fusion ignition simulation
- Parallel algorithms for bio- and pharmacy applications
- Parallel algorithms for weather forecasting based on GRAPES
- 10000+ core scale simulation for aircraft design
- Seismic imaging for oil exploration
- Parallel algorithm libraries for PetaFlops systems

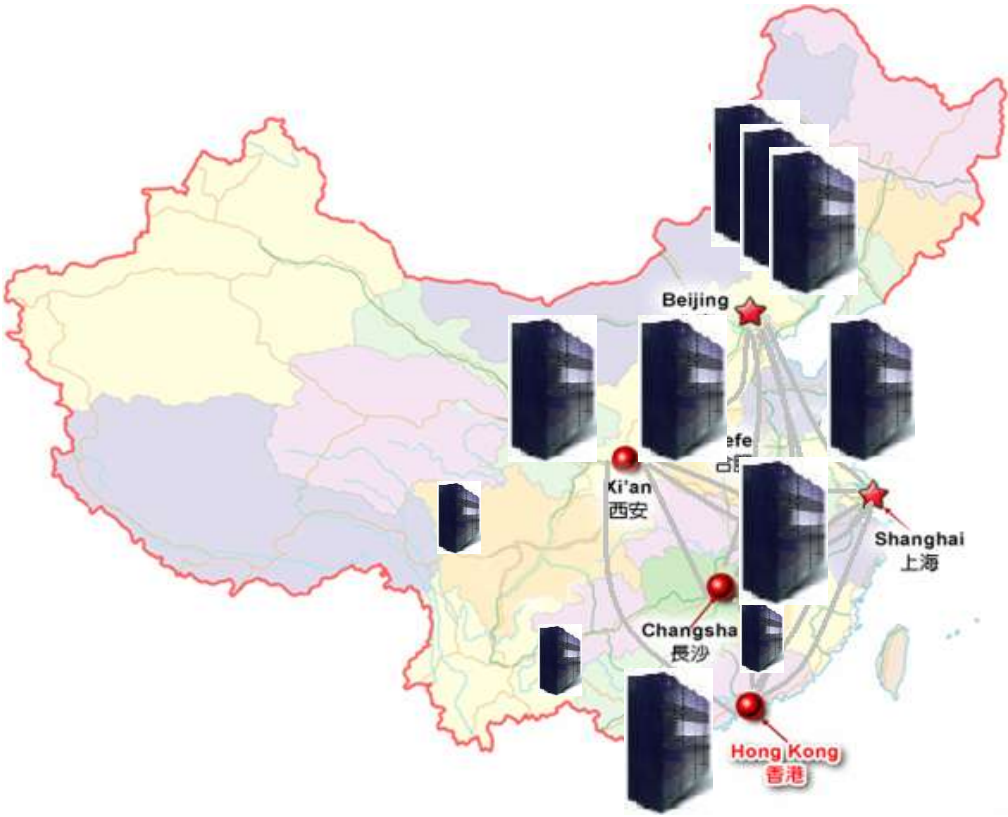



Domain application Grids

- Domain application Grids for
  - Simulation and optimization
    - automobile industry
    - aircraft design
    - steel industry
  - Scientific computing
    - Bio-information application
    - computational chemistry
- Introducing Cloud Computing concept
  - CNGrid—as IaaS and partially PaaS
  - Domain application Grids—as SaaS and partially PaaS

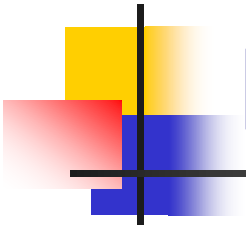
CNGrid (2006-2010)

- HPC Systems
  - Two 100 Tflops
  - 3 PFlops
- Grid Software: CNGrid GOS
- CNGrid Environment
  - 12 sites
  - One OP Centers
  - Some domain application Grids
- Applications
  - Research
  - Resource & Environment
  - Manufacturing
  - Services



China's status in related fields

- Significant progress in certain areas
- Still far behind in many aspects
  - kernel technologies
  - applications
  - multi-disciplinary research
  - talent people
- Sustainable development is crucial



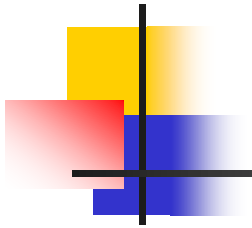
Next 5 years

- **ChinaCloud**
  - **A priority key project that will be launched this year**
    - **Strategic study to identify the goal and the scope of the project**
    - **Network OS, cloud based search engine, and cloud based language translation**
- **High-end computing infrastructure (Still pending)**
  - **Goals?**
  - **Demands?**
  - **HPC in cloud?**

HPC Consortium

- A HPC consortium based on CNGrid is under consideration
- Part of the country's cyber-infrastructure
  - High-end computing facility for research
  - Simulation and optimization capability needed by industry
  - A consortium for taking national R&D projects
- A new model of operation need to be defined

- HKU site is extremely valuable to CNGrid and the future consortium
  - Effective operation
  - Supporting applications
  - Promoting international cooperation



Thank you!