Brief Overview of HPC & Big data in China

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Outline

□ **HPC Projects in China**

□ **NUDT Efforts**

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HPC in China

HPC Funding System

□ **NSFC**

  ➤ **Basic algorithms and computable modeling for high performance scientific computing**

  ➤ **Network based research environment**

  ➤ **Many-core parallel programming**

□ **MOST**

  HiTech 863 program

  ➤ **High productivity computer and Grid service environment**

  ➤ **Multicore/many-core programming support**

  ➤ **HPC software for algorithm and modeling**

  HiTech 973 program

  ➤ **Parallel algorithms for large scale scientific computing**

  ➤ **Virtual computing environment**

HPC in China

- **"High productivity Computer and Grid Service Environment" (Supercomputer project—first phase)**
  - **Period: 2006-2010**
  - **940 million Yuan from the MOST**
  - **more than 1billion Yuan matching money from other sources**
- **Major R&D activities**
  - **Developing PFlops computers (TH-1A, Nebula, Shenwei)**
  - **Building up a grid service environment--CNGrid**
  - **Developing Grid and HPC applications in selected areas**

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HPC in China

NSFC

☐ **Basic algorithms and computable modeling for high performance scientific computing**

- ➤ **8-year, launched in 2011**
- ➤ **180 million Yuan funding**

☐ **Focused on**

- ➤ **Novel computational methods and basic parallel algorithms**
- ➤ **Computable modeling for selected domains**
- ➤ **Implementation and verification of parallel algorithms by simulation**

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Hi-Tech 863 for application

☐ **Eight strategic applications(2012)**

  ➢ **Fusion**

  ➢ **Aircraft Design**

  ➢ **Space & cosmic**

  ➢ **Drug Design**

  ➢ **Animation**

  ➢ **Mechanics of Giant Engineering Equipment**

  ➢ **Electromagnetic Environment Simulation**

  ➢ **New Material**

HPC in China

▭ **Second Phase of Supercomputer Project**

▭ **12-FiveY project (-2015)**

  ➢ **System**

   ◆ **100PFlops**

   ◆ **More than 2X investment comparing 11-FiveY project**

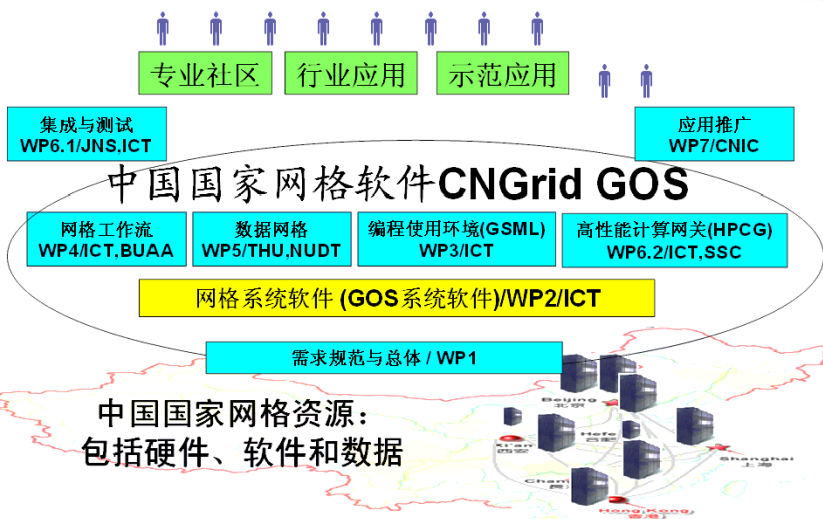   – **MOST (863)**

    – **Local government**

   1. **Tianhe-2 33.86/54.9PFlops now, 2015 ~100PFlops**

   2. **Shenwei-x ~100PFlops**

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HPC in China

□ CNGrid: Resources

➢ **14 sites**

➢ **>7PFlops**

➢ **16PB storage**

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北京应用物理与计算数学研究所

国家超算天津中心

中科院超算中心

国家超算济南中心

甘肃省计算中心

山东大学

西安交通大学

中国科技大学

上海超算中心

华中科技大学

国家超算深圳中心

中科院深圳先进技术研究院

香港大学

专业社区 行业应用 示范应用

| 集成与测试 WP6.1/JNS,ICT | | | 应用推广 WP7/CNIC |

中国国家网格软件 CNGrid GOS

| 网格工作流 WP4/ICT,BUAA | 数据网格 WP5/THU,NUDT | 编程使用环境(GSML) WP3/ICT | 高性能计算网关(HPCG) WP6.2/ICT,SSC |

网格系统软件 (GOS系统软件)/WP2/ICT

需求规范与总体 / WP1

中国国家网格资源：
包括硬件、软件和数据
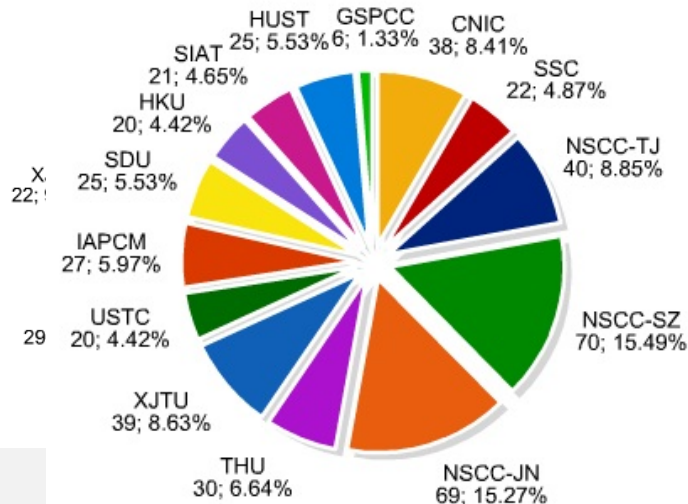
2013.4

HPC in China

□ **CNGrid**

  ➢ **450 services**

  ➢ **>2800 users**

  ➢ **Supporting >1100 projects**

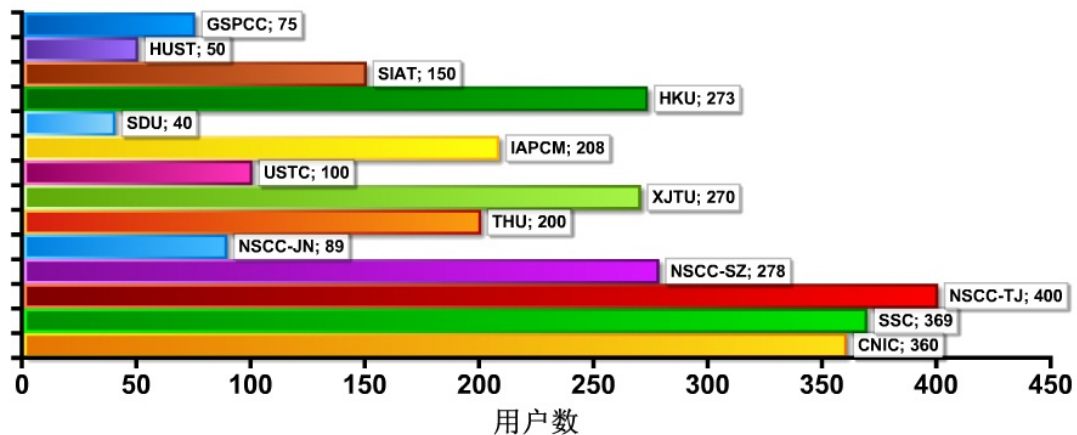 ◆ **973, 863, NSFC, CAS Innovative, and Engineering projects**

2013.4

中国国家网格中的服务
部署服务总数452

HUST 25; 5.53% GSPCC 6; 1.33% CNIC 38; 8.41%
SIAT 21; 4.65% SSC 22; 4.87%
HKU 20; 4.42% NSCC-TJ 40; 8.85%
SDU 25; 5.53%
X. 22;
IAPCM 27; 5.97% NSCC-SZ 70; 15.49%
USTC 29 20; 4.42%
XJTU 39; 8.63%
THU 30; 6.64% NSCC-JN 69; 15.27%

CNGrid Users
Total Users: 1456

中国国家网格的用户
用户总数2862

GSPCC; 75
HUST; 50
SIAT; 150
HKU; 273
SDU; 40
IAPCM; 208
USTC; 100
XJTU; 270
THU; 200
NSCC-JN; 89
NSCC-SZ; 278
NSCC-TJ; 400
SSC; 369
CNIC; 360

用户数

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Latest Project (2-1)

☐ **Third Phase of Supercomputer Project**
  ➢ **HiTech 863 project Supported by MOST**
  ➢ **2 years plan (2015-2016)**
  ➢ **Less budget**

1. Preliminary research for Exascale system
  ➢ **Advanced and feasible Architecture**
    ◆ **Goal 30GFlops/W**

2. Domain Application Framework and Tool
  ➢ **CFD**
  ➢ **Energy and Material**

Latest project (2-2)

□ **Big Data Project**

➢ **In-memory computing system**

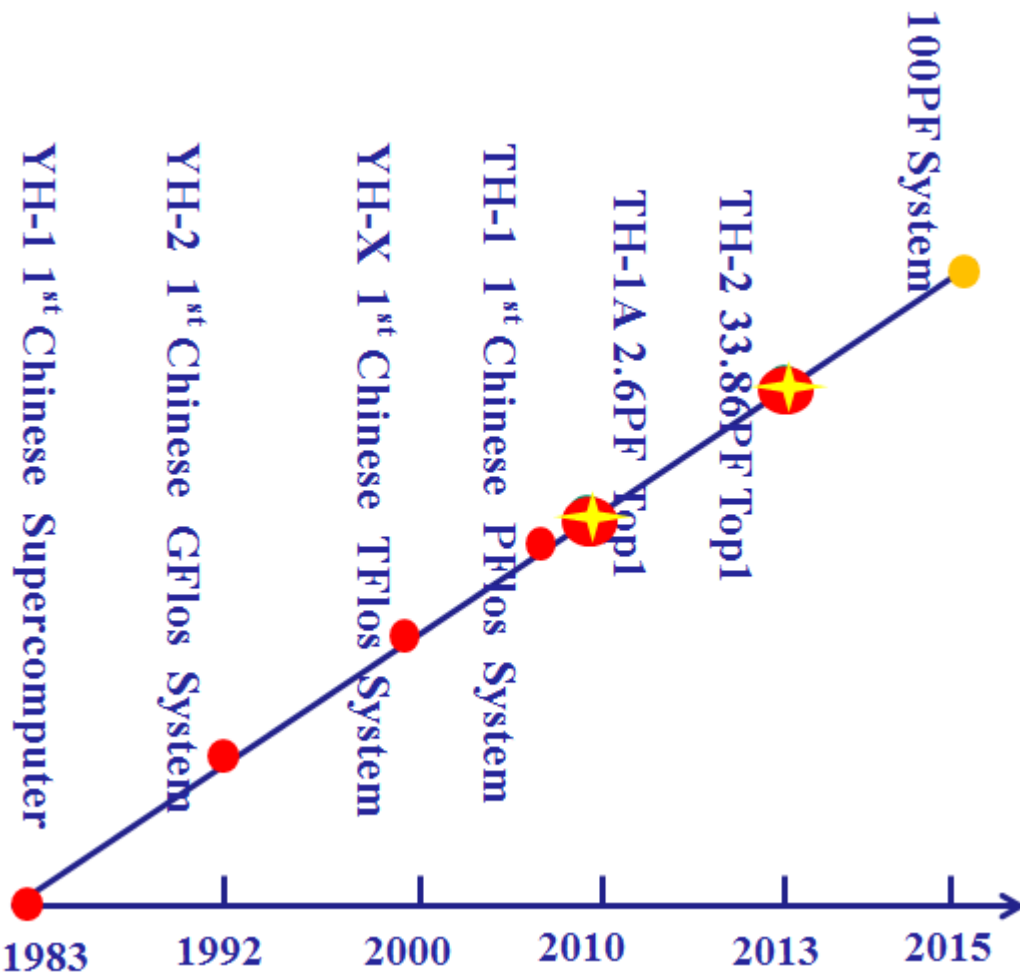◆ **Hybrid memory management policy**

◆ **Parallel system**

➢ **Key technology and system of Human Intelligence**

◆ **Knowledge acquisition, Deep learning, Content understanding, Problem solving, Interactive quizzes,**

◆ **Prototype system: humanoid answer**

NUDT Efforts

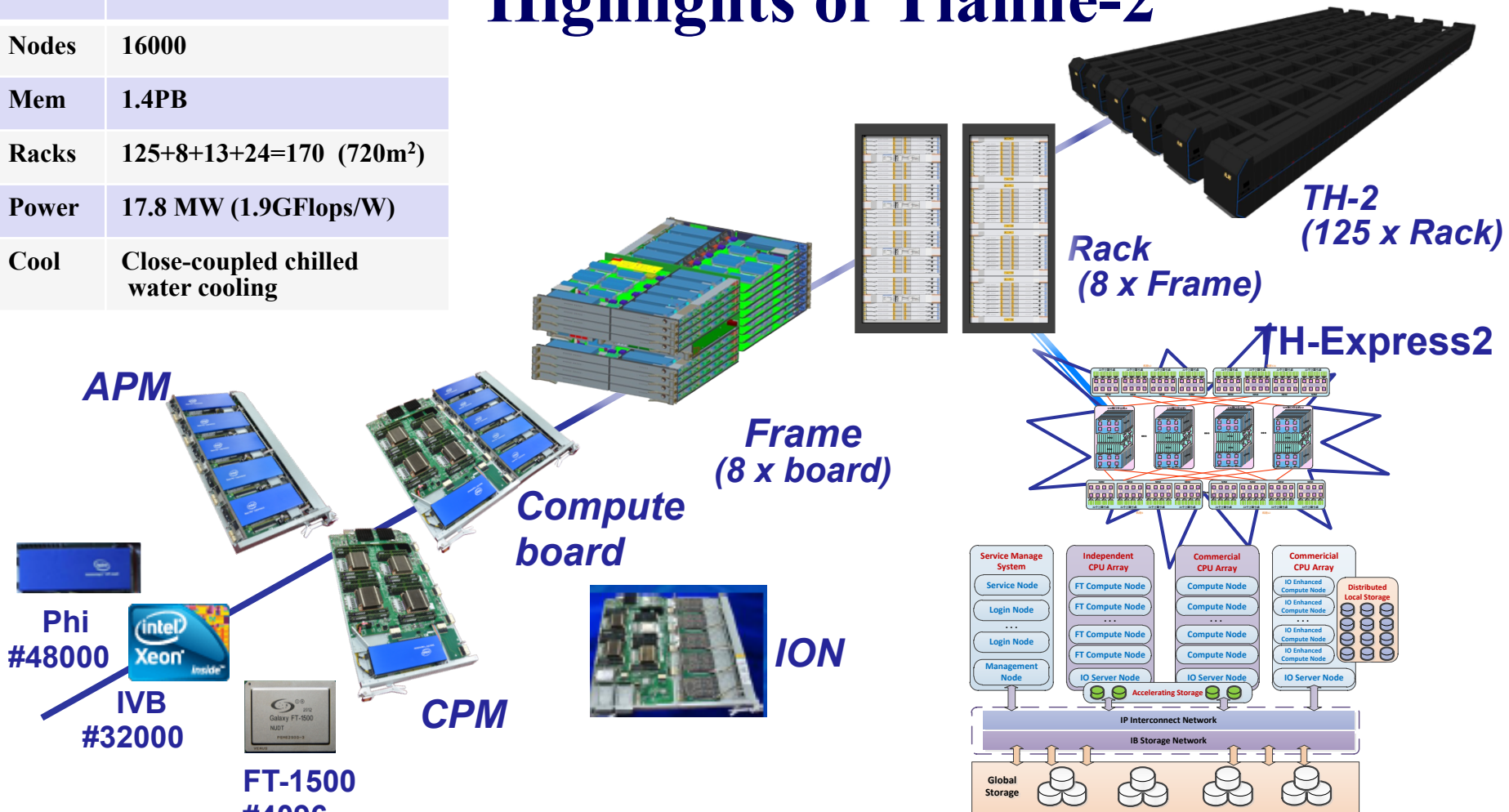## Supercomputers in NUDT, Changsha, China

NSCC-Tianjin,2010

NSCC-Guangzhou,2013

NSCC-Changsha,2012

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NUDT Efforts

Tianhe♪ 天河

Highlights of Tianhe-2

Perf	54.9PFlops / 33.86PFlops
Nodes	16000
Mem	1.4PB
Racks	125+8+13+24=170 (720m^2)
Power	17.8 MW (1.9GFlops/W)
Cool	Close-coupled chilled water cooling

TH-2 (125 x Rack)

Rack (8 x Frame)

TH-Express2

Frame (8 x board)

APM

Compute board

Phi #48000

intel Xeon inside

IVB #32000

Galaxy FT-1500 NUDT

FT-1500 #4096

CPM

ION

Service Manage System	Independent CPU Array	Commercial CPU Array	Commericial CPU Array	
Service Node	FT Compute Node	Compute Node	IO Enhanced Compute Node	Distributed Local Storage
Login Node	FT Compute Node ...	Compute Node ...	IO Enhanced Compute Node	
...	FT Compute Node	Compute Node	IO Enhanced Compute Node	
Login Node	FT Compute Node	Compute Node	IO Enhanced Compute Node	
Management Node	IO Server Node	IO Server Node	IO Server Node	

Accelerating Storage

IP Interconnect Network

IB Storage Network

Global Storage

Hybrid Hierarchy shared storage System
H^{2}FS   12.4PB

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NUDT Efforts

- **Top1(2013.6/11)**
  - **33.86PFlops/54.9PFlops**

- **Graph6 (2013.6/11)**
  - **2061GTEPS**
  - **8192 nodes without using MIC**
  - **2^{36}**

- **GreenGraph6 (2013.6)**
- **GreenGraph11(2013.11)**
  - **9.744GTEPS, 1 node with 2 ivy cpu**
  - **39.29 MTEPS/W 2^{26}**

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NUDT Efforts

☐ **Tianhe-2 in 2015**

- ➢ **100PFlops**

- ➢ **Heterogeneous parallel architecture**

- ➢ **TH-express2$^+$ interconnection network**

- ➢ **Hybrid Hierarchy I/O storage and file system**

- ➢ **HPC & Big data Configurable Software stack**

- ➢ **Domain specific programming framework**

NUDT Efforts

□ **National Supercomputing Center in Guangzhou**

Co-execute with SUN YAT-SEN University

➢ **Big Science**

➢ **Big Engineer**

➢ **Industry Upgrade**

➢ **Information Construction**

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NUDT Efforts

- ❑ **Exascale Architecture**
  - ➢ **Node**
    - ◆ **~10TFlops, many cores**
  - ➢ **Interconnect**
    - ◆ **Optical switch, High radix router**
    - ◆ **System bus**
  - ➢ **I/O**
    - ◆ **Hybrid hierarchy structure**
  - ➢ **>50GFlops/w**
- ❑ **System Software**
  - ➢ **Program model**
  - ➢ **Runtime system**
  - ➢ **File system and Data management**
- ❑ **Application Framework & Tool**
  - ➢ **Domain specific**

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□ **Pre-research on breakthrough Technology**

  ➢ **New enable Tech**

  ◆ **Reconfigurable Arch**

  ◆ **Optical computing and communication**

  ◆ **Nano-electronics**

  ◆ **Quantum computing**

  ➢ **New storage Arch**

  ◆ **Memrist (RRAM)**

  ◆ **Carbon nanotubes**

  ◆ **Graphene**

  ➢ **Creative Software Environment**

  ◆ **Runtime system**

  ◆ **Domain application framework**

Thanks