HIGH PERFORMANCE PARALLEL COMPUTING IN LPSCS

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Institute of Software Application Technology, Guangzhou & CAS

Workshop on Building Collaborations in Clouds, HPC, and Application Areas
The University of Hong Kong; 17 July, 2012

Outline

1. High Performance Computing & Parallel Technology
2. Lab of Parallel Software & Computational Science, ISCAS
3. Research Center of Parallel Software Cloud Application, ISAT GZCAS

High Performance Computing History

- 2002-2005 National 863 Project: High Performance Computer and Core Software
  - TFlops-Dawning 4000&DeepComp 6800
- 2006-2010 National 863 Project: High Productivity Computer and Grid Service Environment
  - 100TFlops-Dawning5000A&DeepComp 7000; 1000TFlops-Tianhe 1A(C+G)& Dawning 6000(C+G) &Sunway Bluelight
  - CNGrid Operation Center: 11sites, Applications
- 2010-2015 Guangzhou Tianhe 2, 100PFlops. Etc .
  - More applications are important

Super Computers in China

Tianhe 1A

Sunway Bluelight

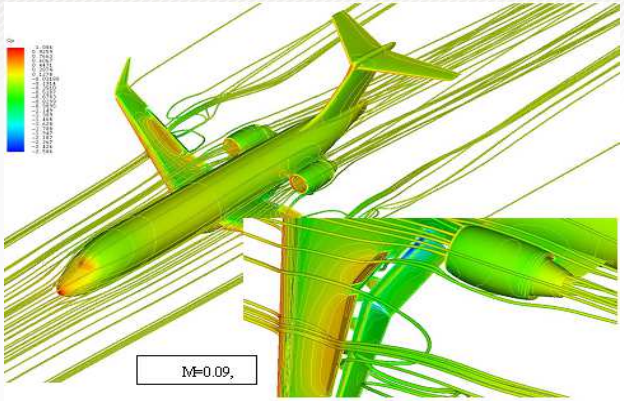
Dawning Nebula

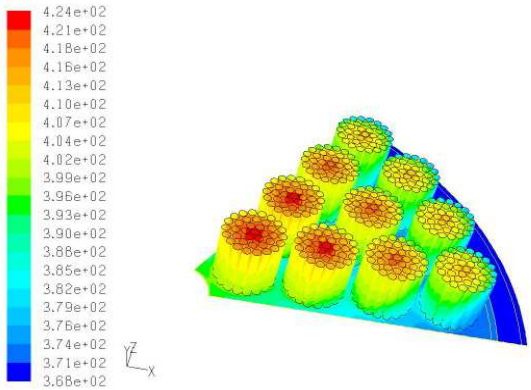
Mole-8.5

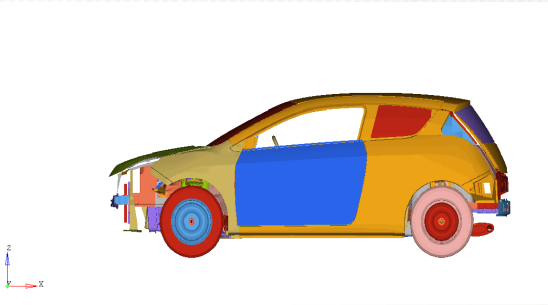
Dawning 5000A

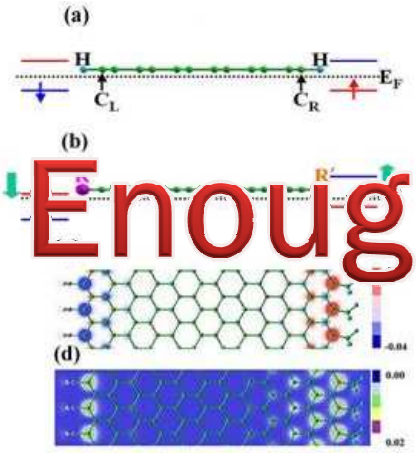
DeepComp 7000

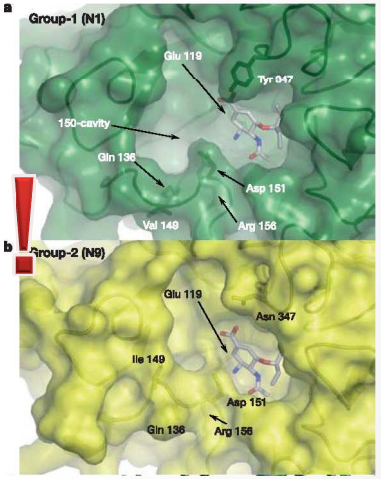
Applications



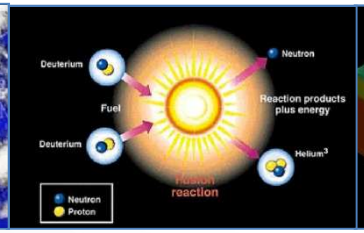


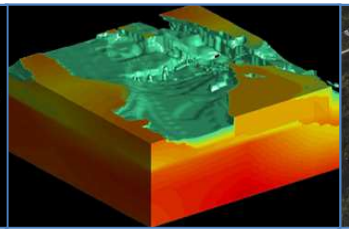


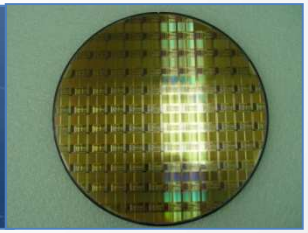




Not Enough At All!







Parallel Technology

Application Model

- Domain Decomposition
- Total Data Partition
- Variables' Physical Character in the Equations

Mathematic

- Discretization and Solvation of Equations
- Computational Scheme: FDM FEM FVM ...
- Algorithm: Direct Method, Iterative Method, Spectral Method...
- High Performance MATH Lib: Blas Lapack Scalapack MKL...

Computation

- Communication Optimation: MPI/OpenMP/Pthread/Etc.
- Hybrid Parallel- Rank&Thread (Eg. MPI+OpenMP)
- Computation meanwhile Communication
- Accelerate Apartment: Eg. GPU

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Institute of Software
Chinese Academy of Sciences

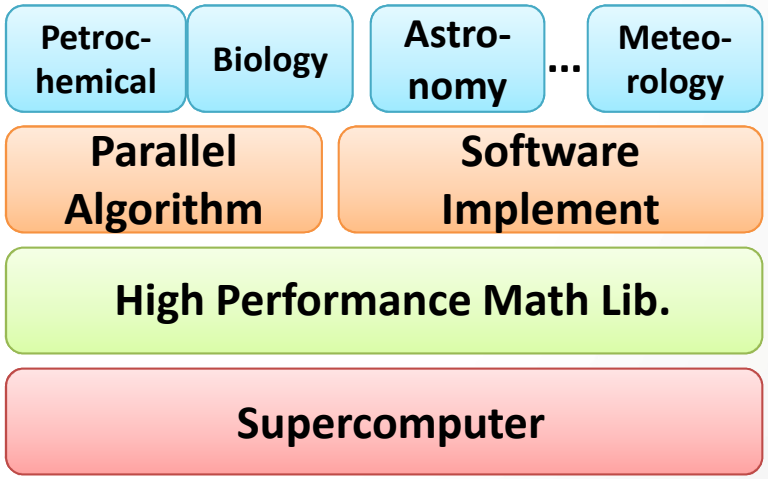
ISCAS is a leading research institute in China, which focuses on the fundamental theories of computer science as well as software technologies and their applications. As a part of the CAS, ISCAS is a government sponsored institution. Through our research results and innovations, we hope to establish an international reputation in academia and to assist in the development and growth of Chinese software industry.

- 2 State Key Laboratory
- 3 National Research Center
- 5 Branch
- 618 Staff Members
- 3 Academician of CAS, 1 The Third World Academy of Science
- National Award for Natural Science: 1st 1, 2nd 2, 3rd 1.
- National Award for Science and Technology Progress: 2nd 6, 3rd 2.

- State Key Laboratory of Computer Science
- State Key Laboratory of Integrated Information System Technology
- National Engineering Research Center of Fundamental Software
- National Engineering Research Center of Information Security
- Division of National Engineering Research Center of Satellite Navigation Application
- Laboratory of Parallel Software and Computational Science
- Technology Center of Software Engineering
- Intelligence Engineering Laboratory
- Laboratory for Internet Software Technologies
- Wuxi Branch
- Chongqing Branch
- Haerbin Branch
- Guangzhou Branch
- Qingdao Branch

Lab of Parallel Software & Computational Science, ISCAS

The major research areas includes research on parallel algorithm, development of parallel numerical and non-numerical software, and technical services for high performance computing. Main research and development projects come from national climbing plan, national 863 project, national science foundation, national 973 project of China, and international corporations, etc. We also have intimate corporations with domestic parallel computer manufactures and industry companies on research of parallel algorithms and development of corresponding parallel software.



Cooperation

- ISCAS-AMD Fusion Software Center
  - AMD
- Argonne MCS-ISCAS Joint Lab for Parallel Processing & Computing Techniques
  - The Mathemetics & Computer Science Division, Argonne National Laboratory
- Joint Laboratory for Parallel Algorithm and Software Research
  - Department of Computer Science University of Colorado at Boulder

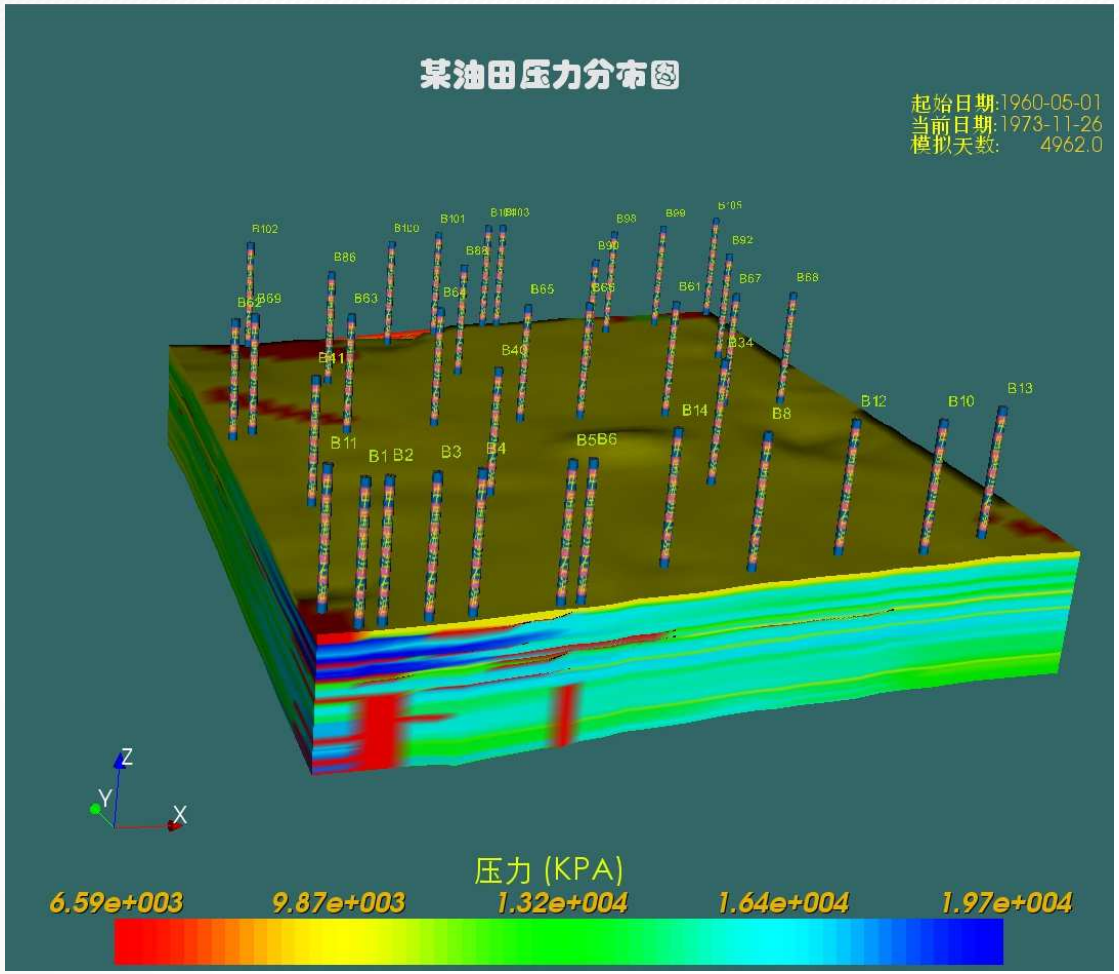
HPC Achievements in LPSCS

- Top 100 List of High Performance Computer
- Parallel Numerical Petroleum Reservoir Simulation Software
- High Performance Mathematics Library
- High Performance Protein Quantification Computation Software Platform
- Astronomical Large-scale Parallel Numerical Computation Software Platform

2011 China TOP100 List of SC www.samss.org.cn

No.	Vendor	High performance computer	Installation Location	Year	Application Area	Cores	Linpack Gflops	Peak Gflops	Efficiency
1	NUDT	TianHe OneA/7168x2 Intel Hexa Core Xeon X5670 2.93GHz + 7168 Nvidia Tesla M2050@1.15GHz+2048 Hex Core FT-1000@1GHz/ 80Gbps	National Supercomputer Center in Tianjin	2010	Sci.Comp/Industry	202752	2566000	4701000	0.546
2	NPCETR	Sunway BlueLight /8575x16 Core SW1600@975MHz/QDR Infiniband	National Supercomputer Center in Jinan	2011	Sci.Comp/Industry	137200	795900	1070160	0.744
3	NUDT	TianHe OneA-HN/2048x2 Intel Hexa Core Xeon X5670 2.93GHz + 2048 Nvidia Tesla M2050@1.15GHz/ 80Gbps	National Supercomputer Center in Changsha	2011	Sci.Comp/Industry	53248	771700	1343200	0.575
4	SUGON	SUGON NEBULA/ TC3600 Blade/2560x(2 Intel Hexa Core X5650+Nvidia Tesla C2050 GPU)/QDR Infiniband	National Supercomputer Center in Shenzhen	2011	Sci.Comp/Industry	52416	749200	1296320.26	0.578
5	IBM	xSeries x3650M3/Intel Xeon X56xx 2.53 GHz/Giga-E	Network Company	2011	Internet Service	113040	636985	1143965	0.557
6	IPE,CAS	Mole-8.5 Cluster/320x2 Intel QC Xeon E5520 2.26 Ghz + 320x6 Nvidia Tesla C2050/QDR Infiniband	Institute of Process Engineering, CAS	2010	Sci.Comp	33120	496500	1138440	0.436
7	SUGON	SUGON NEBULA /Sugon TC3600 Blade/3040 x 2 Intel Hexa Core X5650/QDR Infiniband	National Supercomputer Center in Shenzhen	2011	Sci.Comp/Industry	36480	342300	389168.64	0.88
8	IBM	xSeries x3650M3/Intel Xeon X56xx 2.93 GHz/Giga-E	Telecom Company	2011	Industry	36336	204754.4	425856	0.481
9	IBM	xSeries x3650M2 Cluster/Intel Xeon QC E55xx 2.53 GHz/Giga-E	Network Company	2011	Internet Service	34688	196228	351044	0.559
10	SUGON	Magic Cube /SUGON 5000A/1920x4 AMD QC Barcelona 1.9GHz/DDR Infiniband/WCCS+Linux	Shanghai Supercomputer Center	2008	Sci.Comp/Industry	30720	180600	233472	0.774

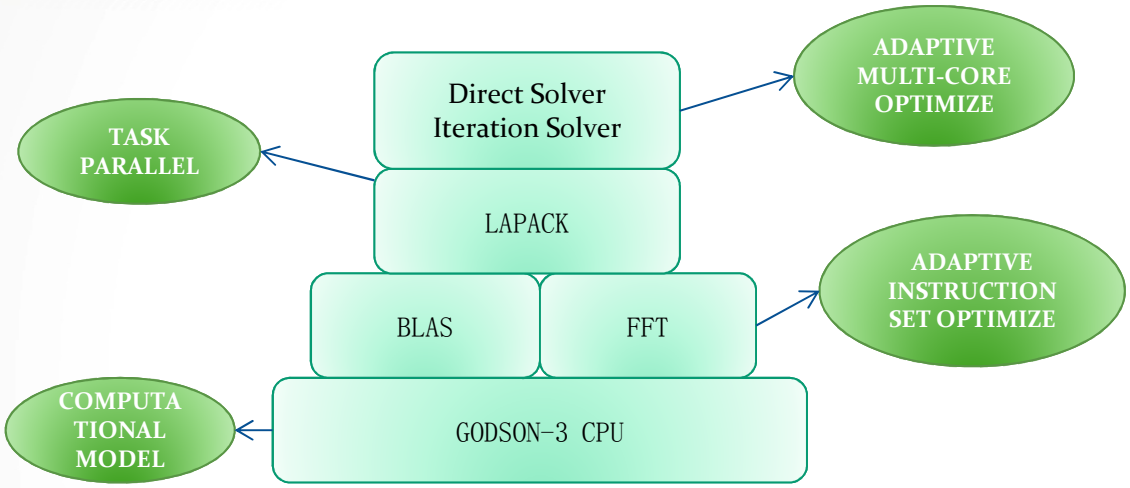
Parallel Numerical Petroleum Reservoir Simulation Software

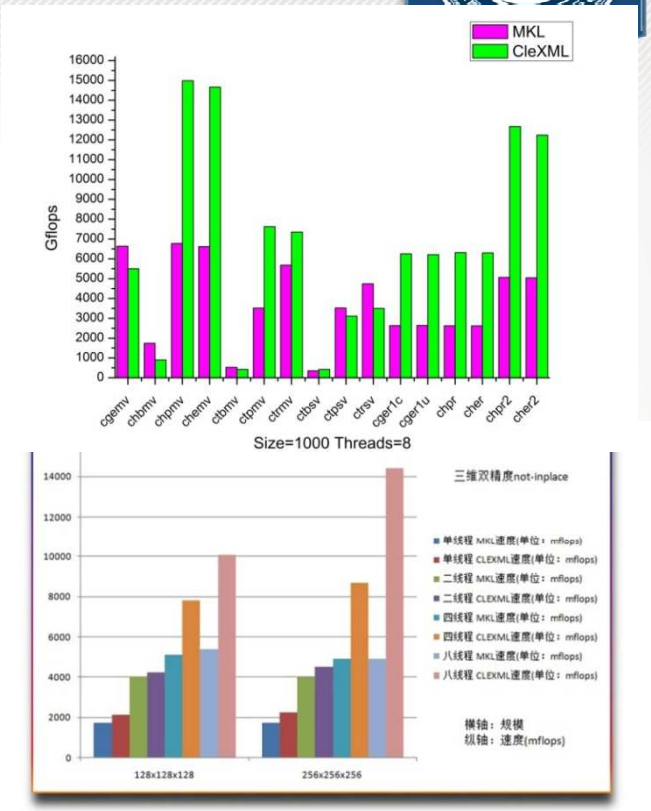


➢Simulate Underground oil-water flows, predict the dynamics of petroleum reservoir. Provide scientific drilling decisions, reduce development risk. Important for high and stable yield of old oil field. Won the second prize of National Award for Science and Technology Progress.

➢**Application**: PetroChina, Sinopec, CNOOC, Shengli Oil Field and Daqing Oil field

Multi-core High Performance Math Library (CLeXM)





➢**Multi-core High Performance Math Library (CLeXM) for Godson-3 CPU**： Standard API and functions， performance better main stream HPC math lib.， contains BLAS、LAPACK、FFT、direct solver and iteration solver modules.

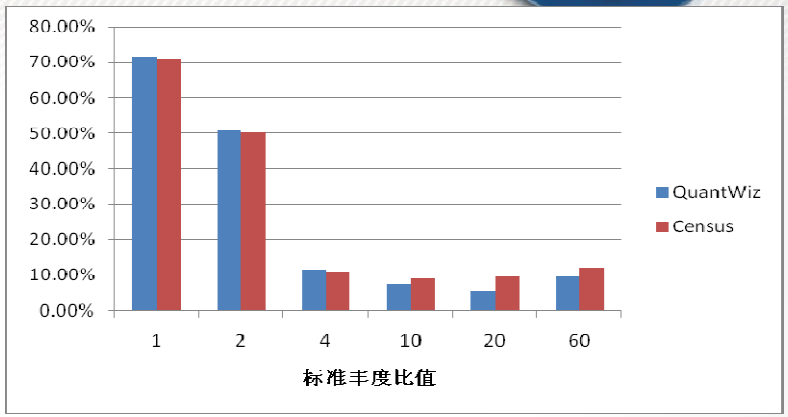
➢**Source**： **National "HGJ" Major Program:** Godson CPU Multi-core High Performance Math Library

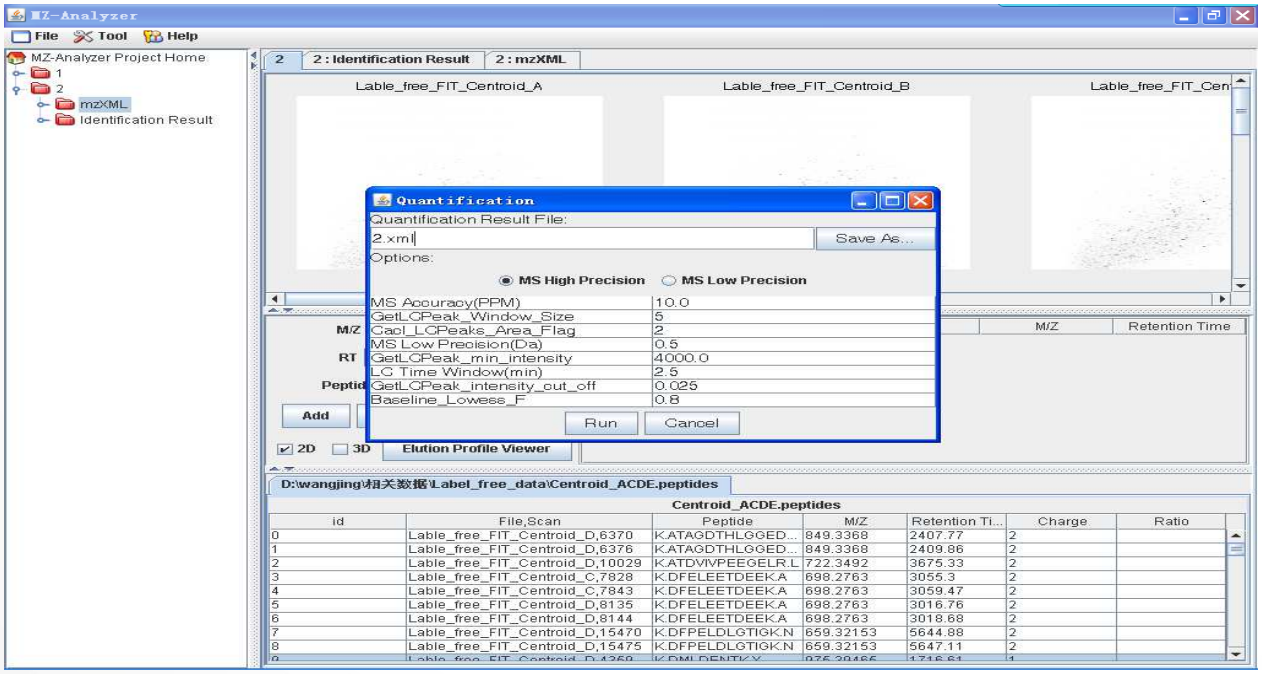
➢**Application**： Loongson Corp.

High Performance Protein Quantification Computation Software Platform

➢ **Protein Label-free Quantification Software (QuantWiz)**: After standard data test, its label-free quantificational accuracy is close to or better than the main stream quantification software Census; label quantificational accuracy better than ASAP Ratio.

➢ **Source**: CAS Knowledge Innovation Project-major project "High Performance Computing Research For the Frontiers of Life Science"

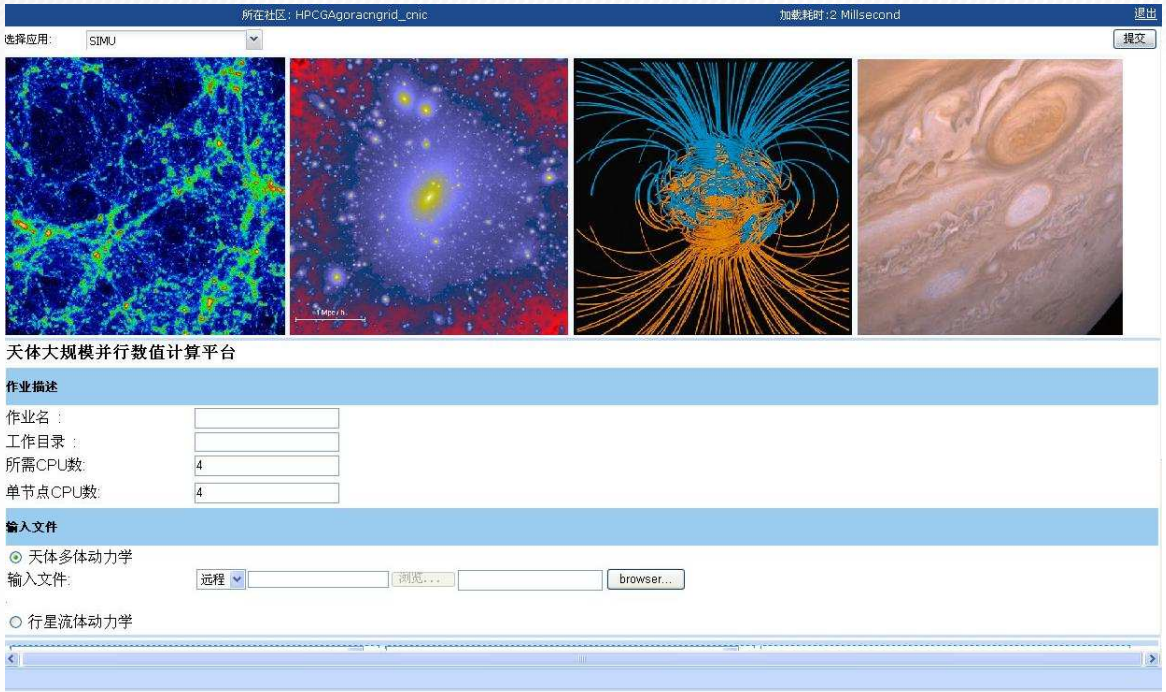


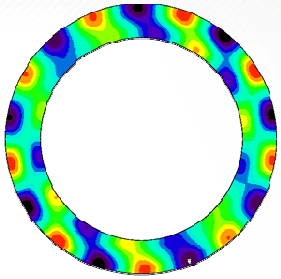


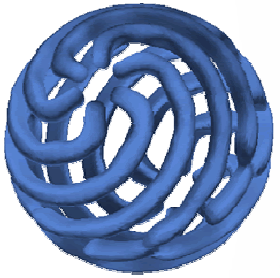
Finished JAVA and C++ versions. Contains data, quantification flow, presentation layers. Develops multi-core M-QuantWiz, MPI P-QuantWiz, GPU G-QuantWiz, MPI+GPU PG-QuantWiz.

➢**Application**: Shanghai Institutes for Biological Sciences, CAS

Astronomical Large-scale Parallel Numerical Computation Software Platform



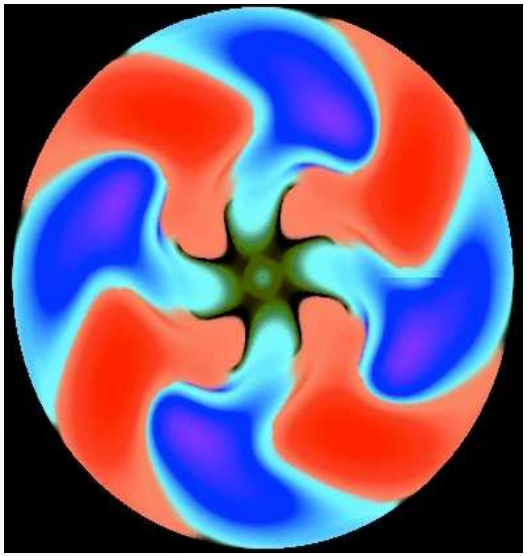


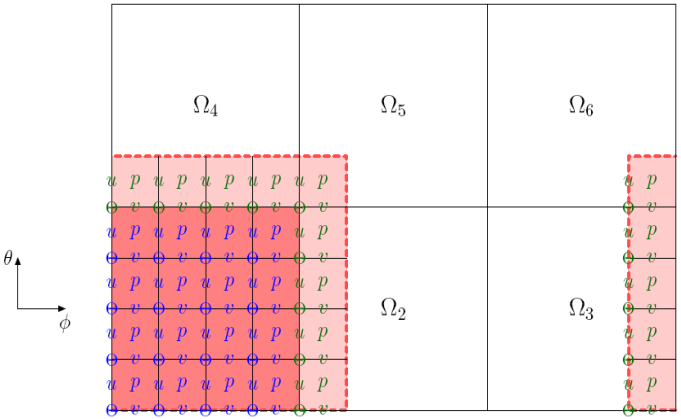


- **Planetary Fluid Dynamics Large-scale Numerical Simulation Parallel Software:** The key technologies of the new parallel computational model and algorithm, the efficient large-scale sparse matrix solver, the program fixed to the hardware structure, the mass data processing and the parallel visualization; highly improved the computational performance.
- **Source:** National 863 Project - Astronomical Large-scale Parallel Numerical Computation Software Platform
- **Application:** Shanghai Astronomical Observatory, CAS

Scalability on Tianhe 1A

Simulation of the earth outer-core fluid flowing by domain decomposition, Scalability from 3,000 to 24,000 cores on Tianhe 1A, parallel efficiency reach to 87%, and the mesh scale firstly got to 12 billion grid points.





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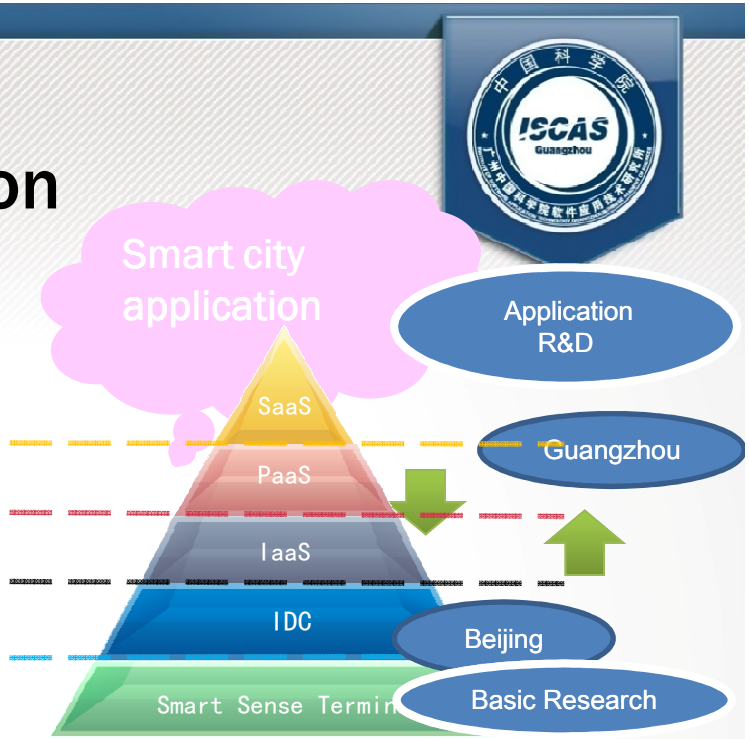
GZIS Introduction

- **Institute of Software Application Technology, Guangzhou & CAS (**GZIS), founded in May 27, 2011by Guangzhou Government and CAS, is one of the advanced demonstration unit of Guangzhou Government innovation development model.

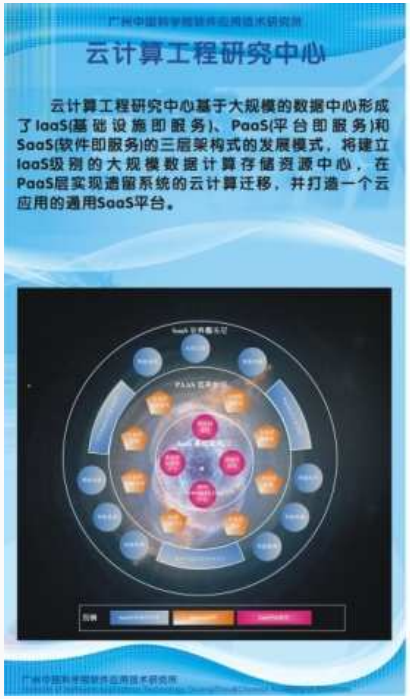
- GZIS is the Guangzhou branch of ISCAS , fully relies on the strong research capability of ISCAS , with market oriented, combines local policy, human resources and market advantages, cooperates closely with local government, industry, academy and research, focus on R&D production in Smart City, Cloud Computing and HPC, hope to promote the rapid development of software industry in Guangzhou.



Research Areas

Industrial Model

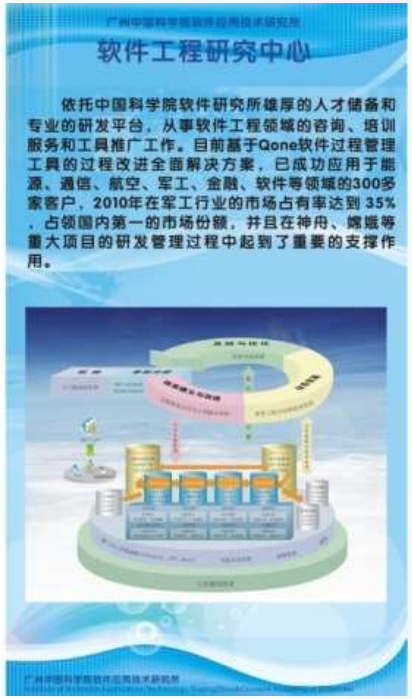
Other Research Centers



Cloud Computing

Internet of Things

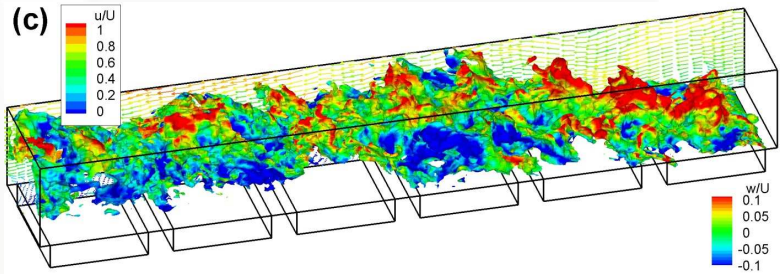
Smart City

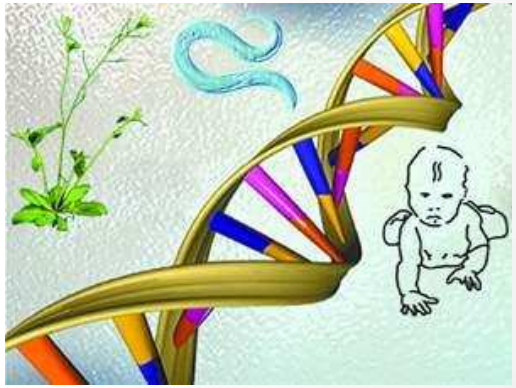


Software Engineering

Research Center of Parallel Software Cloud Application

In the frontiers of computational science, choosing the application areas important to the development of national economy, focusing on R&D of parallel computing methods, parallel numerical simulation and mass data processing.

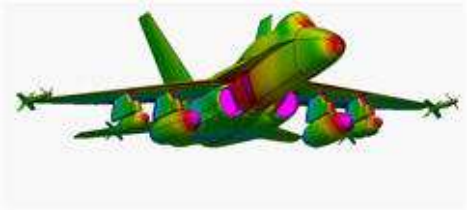


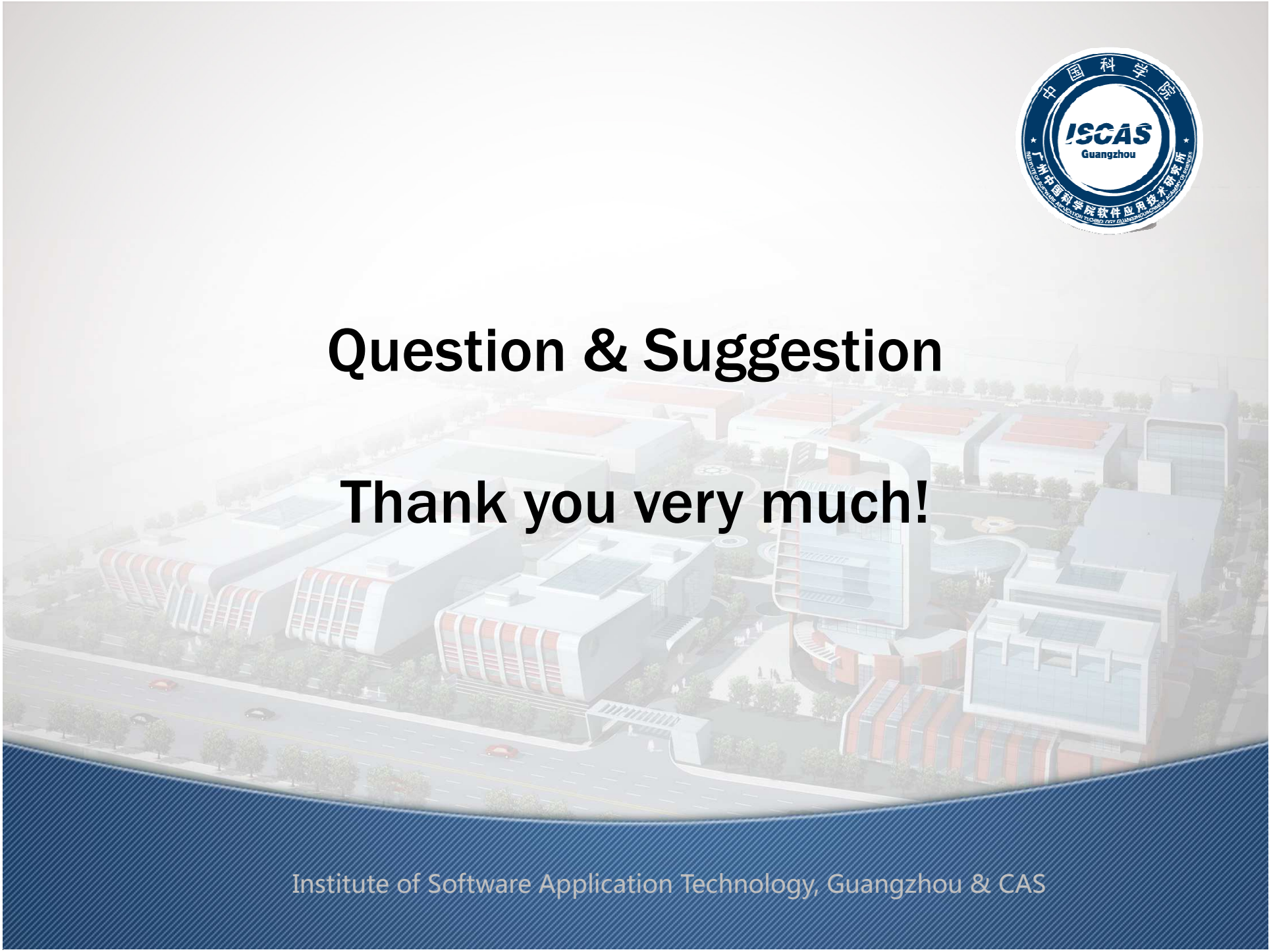


Super computers

Burning money? or Productivity?

Do things for the people!
HPC, Cloud computing, Internet of things, Smart city, ……





Question & Suggestion

Thank you very much!