
HPC & BD applications in China

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Outlines

- Related R&D programs
- Applications supported
- Perspectives

Related R&D programs

Efforts of national R&D programs

	MOST-863 program	MOST-973 program	MOST-Key R&D program	R&D Mega-Program	NSFC
HPC	3 key projects	3 projects	1 Key project		1 key initiative
BD		6 projects	1 key project	Mega-project on BD to be launched	10+ major projects

Current HPC projects

- Key R&D project: “High Performance Computing” (2016-2020)
 - Next generation supercomputer development
 - HPC applications development
 - CNGrid upgrading and transformation
- NSFC key initiative: “Basic Algorithms and Computable Modeling for High Performance Scientific Computing” (2011-2019)
 - Computable modeling methods
 - Innovative basic algorithms
 - Domain applications for demonstration
- NSFC/Guangdong province joint program on supercomputing
 - Supporting Tianhe-2 users in the form of CPU hours
 - 600+ projects supported

Current BD projects

- Cloud computing and Big Data, key project
 - Software-defined cloud computing
 - Cloud OS
 - Big data storage technologies and platforms
 - Domain-specific big data management system
 - Dataflow-based big data analysis system
 - Big data analytics applications
 - ...
- NSFC/Guangdong province joint project on Big Data Science Center
 - 5-year program, 300 million
 - Supporting about 10 projects

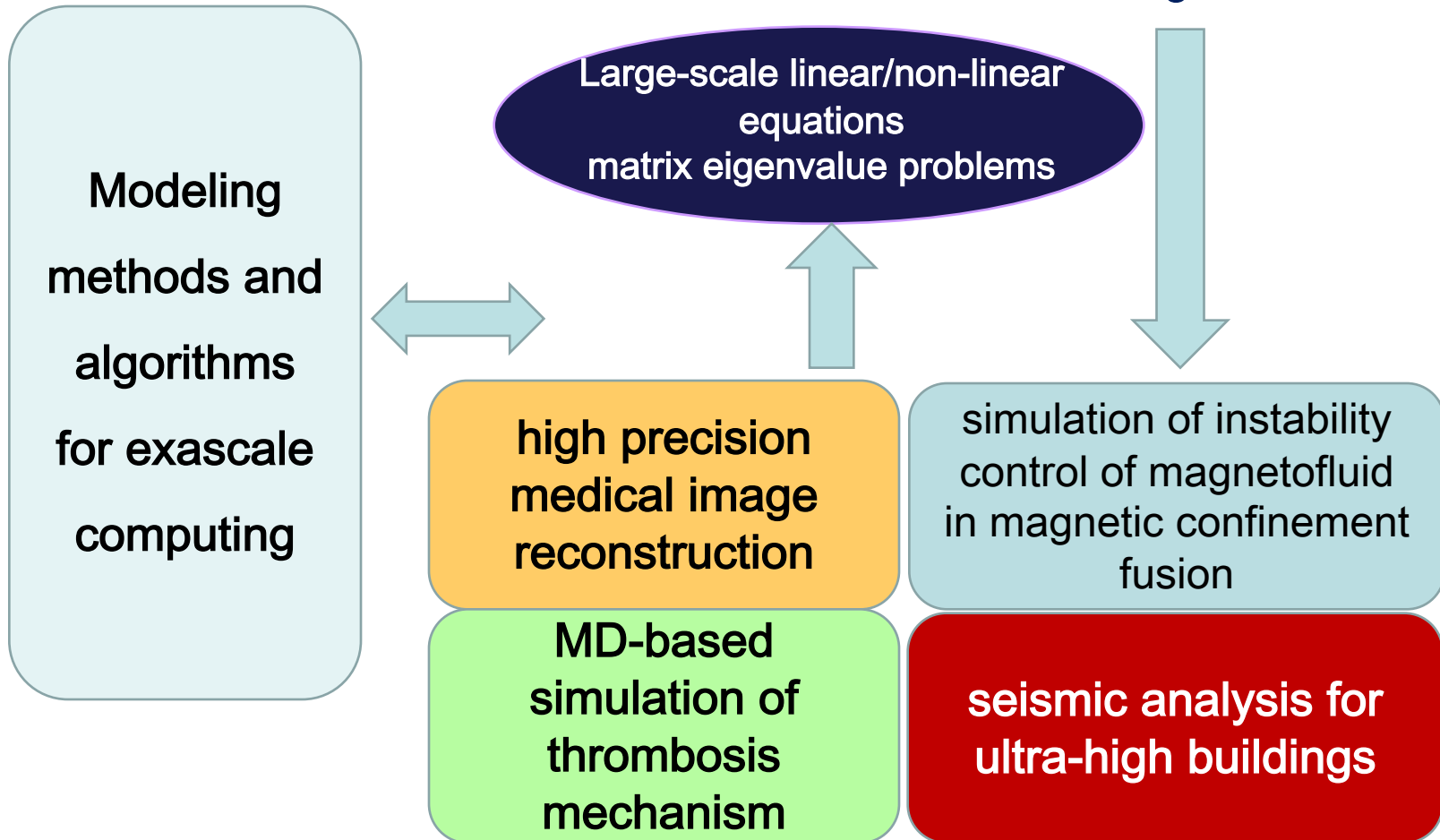
Applications supported

Application-related R&D under the HPC project

- Application enabling techniques
 - Modeling methods and optimized algorithms for exascale computing
 - Parallel algorithms & libraries for exascale computing
 - Parallel programming framework
 - HPC application development platform and tools
- Domain application software
 - Numerical devices
 - Domain HPC application software
- CNGrid-based service systems
 - Integrated business platforms
 - Application villages
 - HPC education practice platform

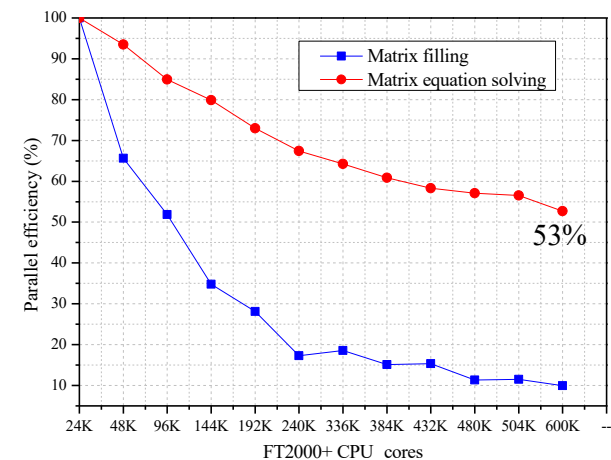
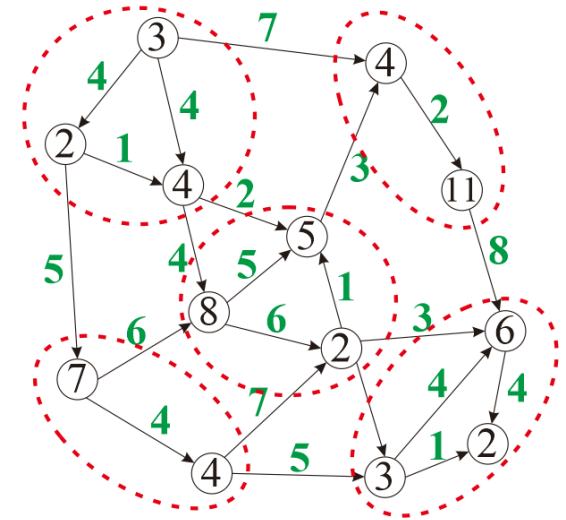
Modeling methods and algorithms for exascale computing

Application-driven novel scalable
basic algorithms



Parallel algorithms and libraries for exascale computing

- Focused on:
 - Efficient method for large-scale mesh generation
 - Direct and iterative solvers for dense matrix problems
 - Parallel solver for sparse matrix problems
 - Parallel solver for particle problems



Parallel Programming framework

Supporting development of 40 application software

辐射流体耦合中子运输	流体力学耦合粒子运输	多介质弹塑性流体力学	ICF二维总体程序	激光等离子体粒子模拟	激光等离子体流体力学
等离子体模拟	关联电子体系模拟	分子动力学模拟	位错动力学模拟	流体力学界面不稳定性	三维蒙卡辐射运输模拟
冲击动力学粒子模拟	三维分子动力学	超高速碰撞动力学模拟	平台级时域电磁模拟	平台级频域电磁模拟	器件级全电磁粒子模拟
弹塑性流体力学模拟	光滑粒子动力学模拟	欧拉流体力学	三维ALE流体力学	结构网格并行Sn软件	三维静态蒙卡粒子运输
全球大气环流模式	全球海洋环流模式	全球海冰模式	冲击动力学分析	非结构网格粒子运输	二维动态蒙卡粒子运输
区域数值天气预报模式	地球系统高分辨率耦合	地下水流动数值模拟	结构静力学分析	模态与振动分析	中子光子耦合粒子运输

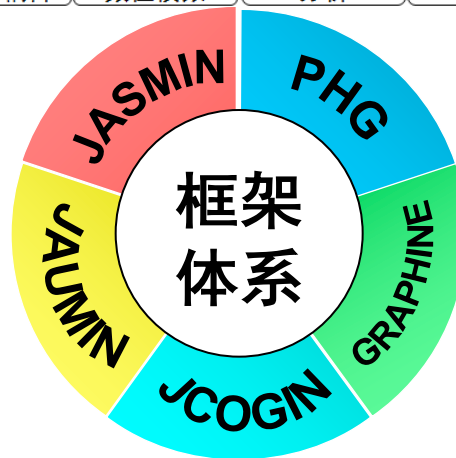
Application achievements

Original innovation

parallel efficiency 30% at 2 million core

Technical innovation

- Structured mesh
- Unstructured mesh
- Mesh-free combinatory geometry
- Finite element
- Graph computing



high-efficient implementation scheme
parallel appl. software dev. method

HPC application development platform and tools

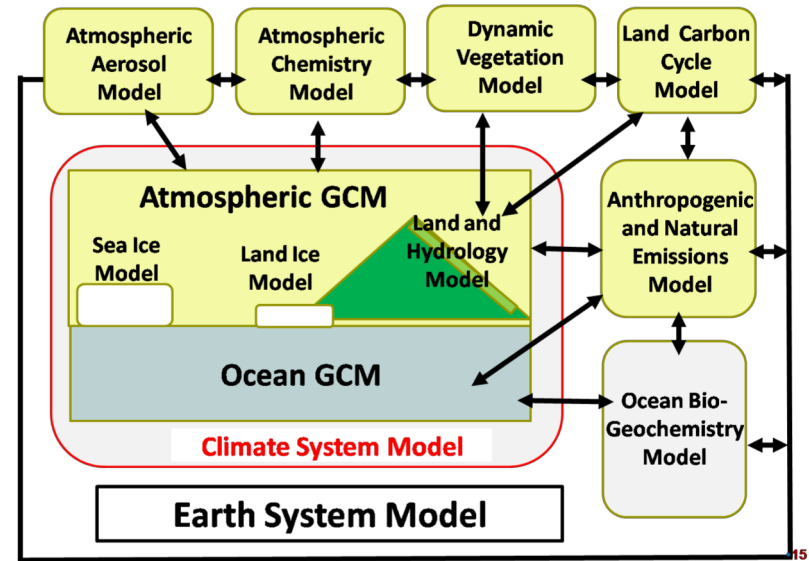
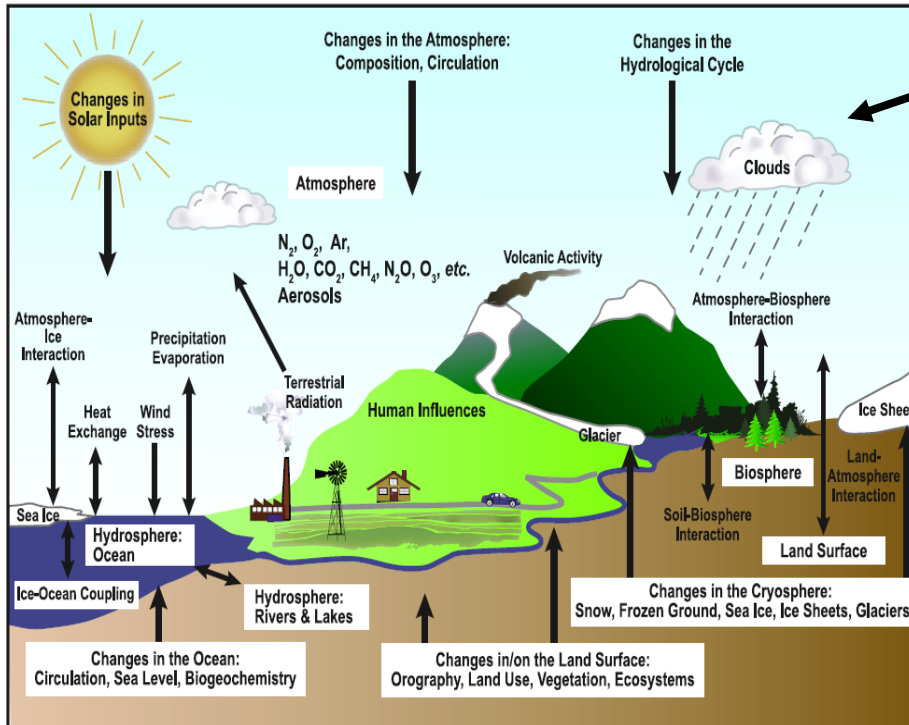
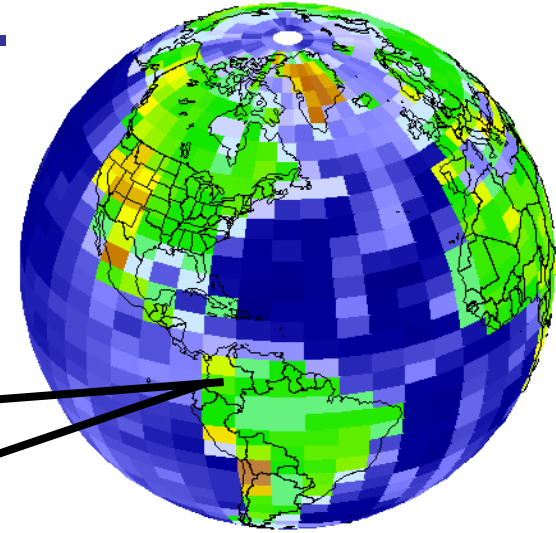
- Building up a platform for HPC software development and optimization
- Developing tools for performance/energy efficiency and pre-/post-processing
- Build up a software resource repository by developing and integrating typical domain application software
- A effort on establishing an application ecosystem for systems based on home-grown processors
 - involving national supercomputing centers, universities, and institutes

Numerical devices

- Numerical device refers to a set of software supporting simulation in a specific application domain
- Four numerical devices are being supported
 - numerical aircraft
 - numerical earth system
 - numerical reactor
 - numerical engine

Numerical Earth System

- earth system modeling for studying climate change
- non-linear coupling of multi-physical and chemical processes covering atmosphere, ocean, land, and sea ice

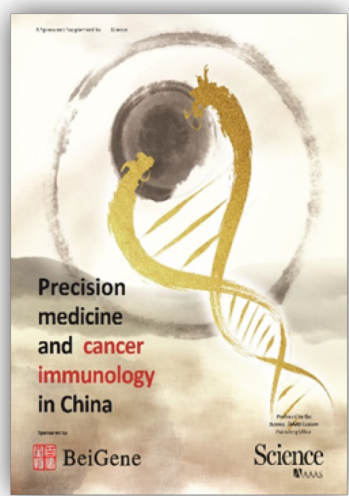


Component Models of the CAS-ESM

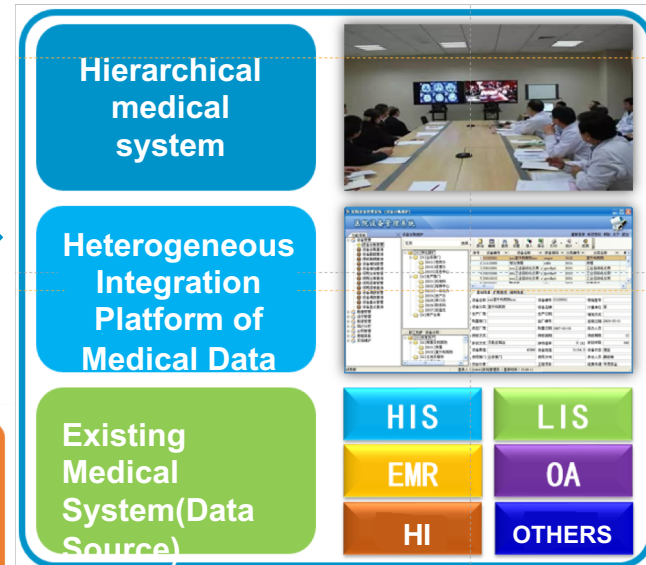
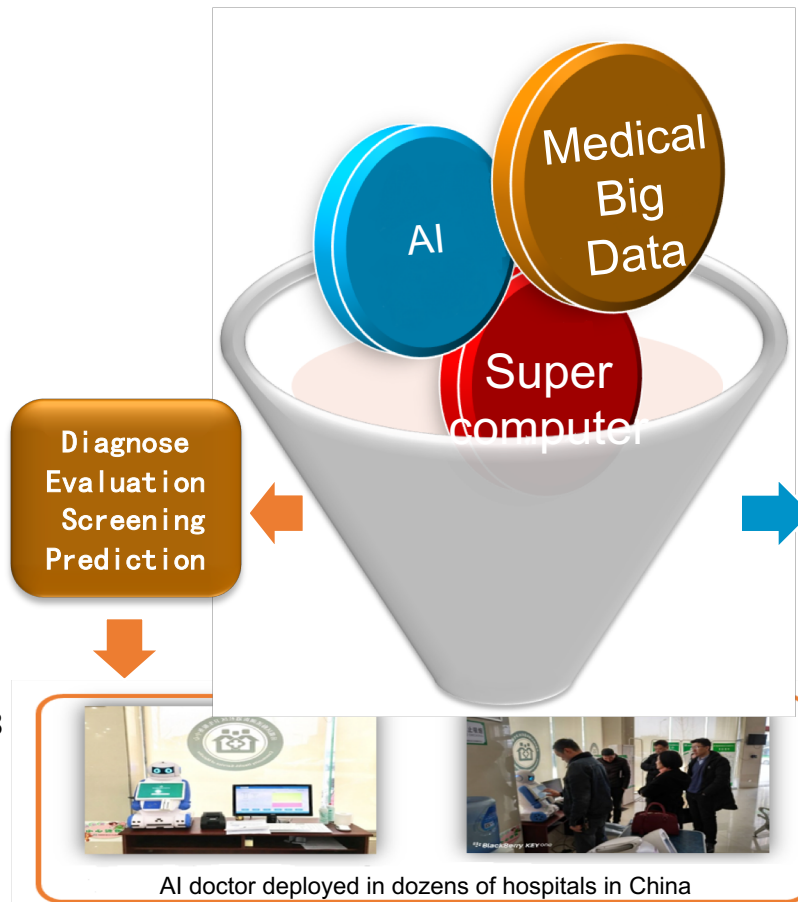
New drug discovery

AI Doctor On Tianhe Supercomputer

- Misdiagnosis rate :Decreased **more than 20%**
- Diagnostic accuracy: Increased **more than 30%**
- The duration of treatment: Reduced **more than 80%**



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Parallel Photo-realistic Rendering

Renderwind - a parallel photo-realistic rendering system for Large Scales Scenes

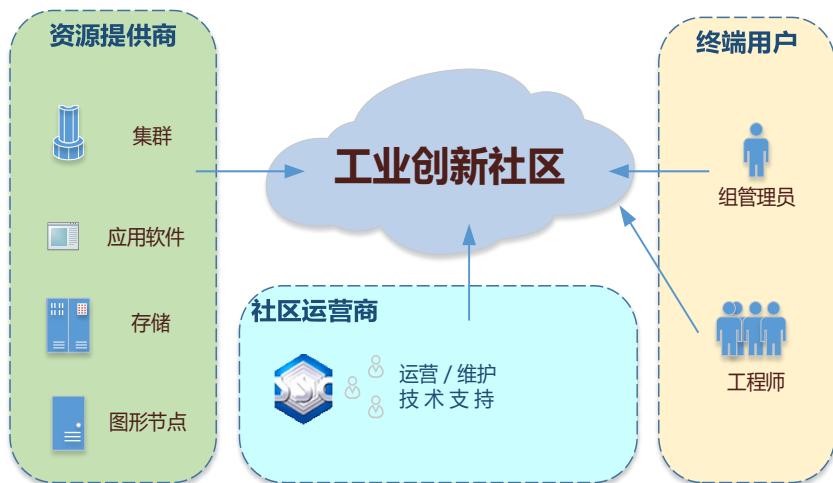


RenderWind Rendering Engine

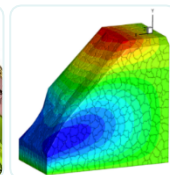
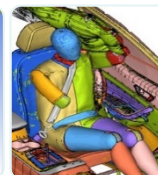
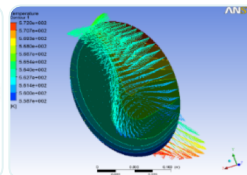
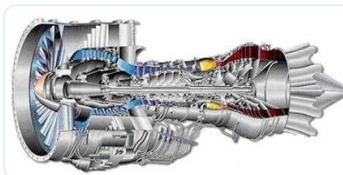
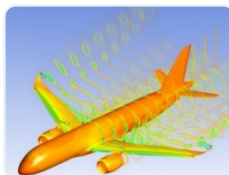
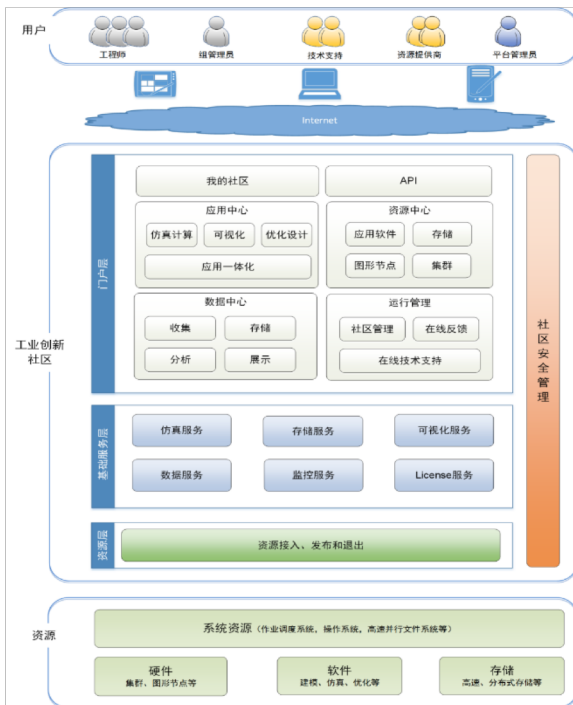


RenderWind Render Farm

CNGrid-based application village: Industrial innovation



- Application community based on CNGrid, combining grid and cloud technologies
- Providing professional services for simulation and production design optimization
- Exploring new business model and mechanism for HPC applications



Applications supported by NSFC/Guangdong joint BD program

- Innovative algorithms and platform for Big Data processing and analysis on Tianhe-2
- Smart city applications
 - Smart health
 - Video surveillance data processing
 - Smart transportation system
 - Geological disaster mitigation
 - Finance applications
 - Precision weather forecast for climate disaster mitigation

Perspectives

Supporting BD & AI applications

- Pay more attention to emerging BD and AI applications requiring HPC capability
 - Treat BD and AI as the first-class citizen
- BigData applications
 - Much broader scope of applications
 - Much higher investment
 - Major industry involvement
 - Require different software stacks and architectural support
- AI applications
 - Very hot topic
 - Potential large investment
 - Require algorithms and novel architecture support
- HPC must embrace the new opportunity brought by BD and AI applications
 - Major supercomputer developers in China are seriously considering support to BD and AI

Pursue converged development

- HPC, BD, and AI are tightly connected and support each other
 - HPC is the basis for big data analytics and deep learning-enabled AI technology and applications
 - Big data changes the way of AI research and applications
- Applications require converged development
 - Each party is indispensable
 - Having three will do much better than having only one
 - Example applications for converged development
 - AI- & BD-enabled scientific discovery
 - Smart medical and healthcare system
- Development of HPC, BD, and AI could be coordinated and converged

Pursue converged development

- Future supercomputer will be deeply influenced by big data and AI
 - Date-centered or dataflow architecture
 - Intelligent accelerators
 - Neuromorphic computing
- Building Software stack supporting HPC, BD and AI
 - Modeling methods and algorithms
 - Programming environment
 - Libraries
 - Performance tools
 - Runtime support

Thank you!