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Updates of Chinese HPC Efforts

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Co-Design in China

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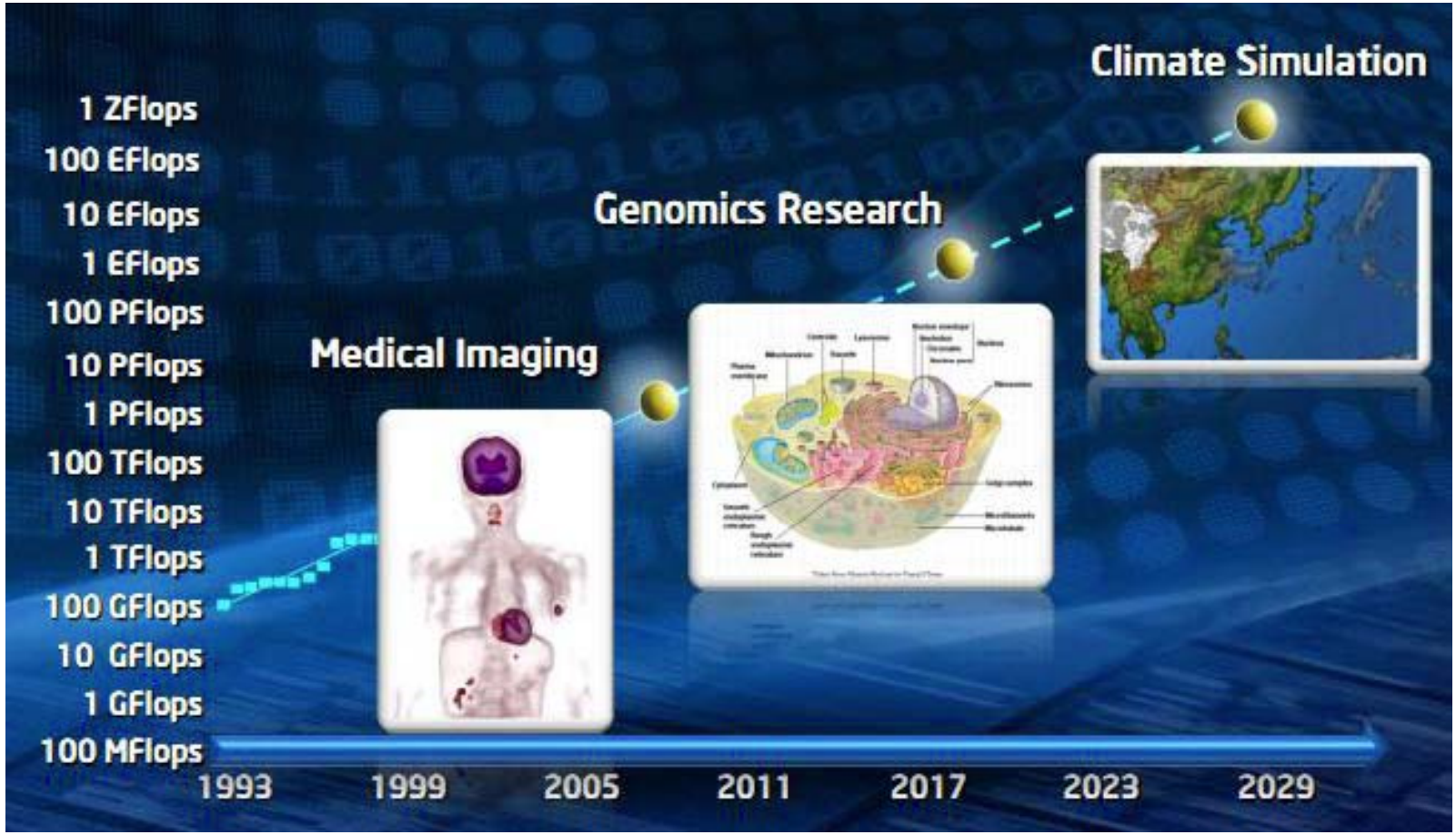
Background



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Background

- "The free lunch is over": CPU performance is no longer boosted by clock speed, but on-chip parallelism. Application software can NOT enjoy regular performance gains from CPU manufactures.

  - Herb Sutter, secretary and convener of the ISO C++ standards committee, Microsoft lead software architect

- "Everything goes parallel" is changing the thinking and practice of computational science and engineering.

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HPC in China: the moment

- **Hardware's performance: high**
  - Tianhe-1A (No.2 on TOP500)
  - Nebulae (No.4 on TOP500)
- **Applications' scale: low**

Tractors crawl on highway

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Co-Design Strategies

- Customized high performance computer for specific application
- Analysis of Computational Characteristics of Applications
  - ➢CPU – Computing intensive
  - ➢ Memory – Memory limited
  - ➢ Storage – I/O intensive
  - ➢ Network – Communication intensive
- Interaction between vendors and software developers

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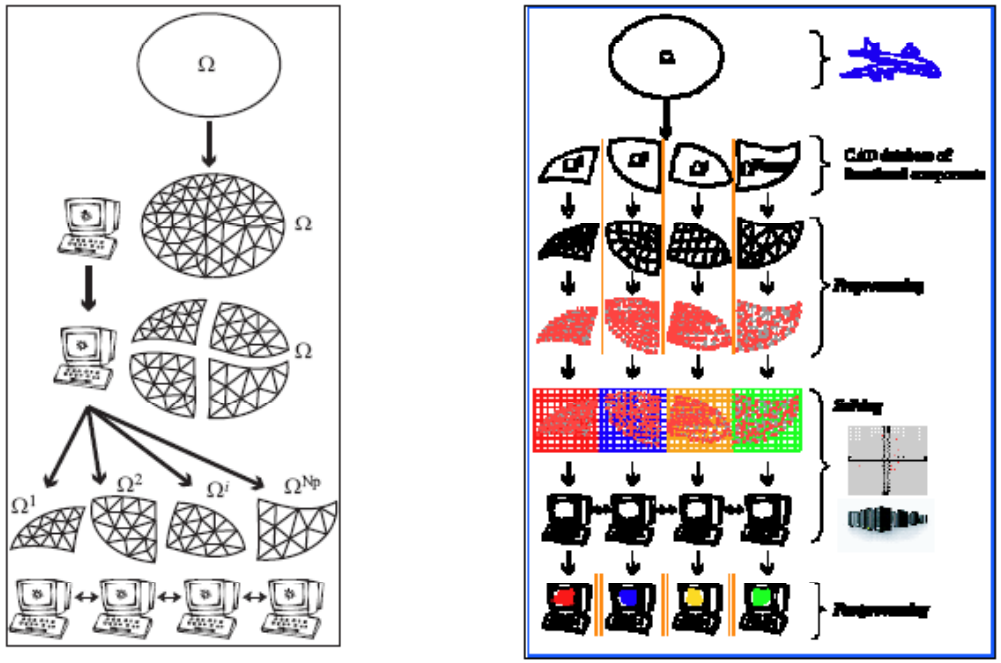
Co-Design: Case Study



(a) Traditional parallel FEM (b) Head-to-toe fully parallel pGFEM

- **Head-to-toe parallel**

Co-design new algorithms on many-cores

*Rong Tian, Institute of Computing Technology, CAS

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Co-Design toward 100 Petaflops Supercomputer

- 863 project (FY 2011~2015) by MOST
  - ➢ Hardware
    - ✓ two 100 Petaflops supercomputers by 2015
  - ➢ Numerical Frame
    - ✓Structural mesh, non-structural mesh, non-mesh geometry and finite element method
    - ✓ Scalable up to ~ 900,000 CPU/cores
    - ✓ Parallel efficiency ~ 30%
    - ✓ budget: 20 Million in RMB

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- Eight strategic applications

  Software system will be developed and can be scaled up to 300, 000 CPU/cores with parallel efficiency of more than 30%

  Budget: ~80 Million in RMB

  - ✓ Fusion
  - ✓ Aircraft Design
  - ✓ Spaceship
  - ✓ Drug Design
  - ✓ Animation
  - ✓ Mechanics of Giant Engineering Equipment
  - ✓ Electromagnetic Environment Simulation
  - ✓ New Type Material Design

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Post-petaflops Era in China

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Funding Agencies of HPC in China

- MOST – 863 Program (HW, SW & Apps)
- CAS – Informization Project (HW, SW & Apps)
- NSFC – General projects (Apps)
- Ministries funding (SW)
- Local government funding (HW)

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- Informization Project (12th Five-year plan)
  - A several Petaflops supercomputer
  - Chinese Scientific Computing Environment
- Software Development Center
  - Goal - to improve computational efficiency in scientific computing and develop software systems
  - Application fields
    - Chemistry, Material Science, Mathematics, Climate, Fluid Dynamics, Bioinformatics, Drug Design, Geophysics and Astrophysics
  - Budget: ~ 30 million in RMB

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- Equipment for Earth System Simulation
  - Peak Performance: > 10 P
  - CPU: Godson (16 cores)
  - Budget: 1 Billion in RMB
  - Visualization system

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NSFC

- Basic Algorithm and Computational Modeling for High Performance Scientific Computing
  - Highly Efficient Algorithm for Numerical Calculation
  - Computational Modeling based on mechanism and data
  - Evaluation on High performance computing and algorithm
- Duration: 2011~2015
- Budget: 37 Millions in RMB (2011)
- Projects: 25

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MOST

- High Performance Computing System toward Earth System Mode
  - ✓Data integration and management
  - ✓Fast visualization and diagnosis of data
  - ✓Development of MPMD program
  - ✓Development environment of earth system mode
- Budget: 31 Millions in RMB

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Supercomputer for the Earth System Simulation

- Peak performance: 172TFlops
- CPU + GPU
- 8880 CPU/Cores
- Bandwith: 40Gbps IB
- Storage: 1PB
- Power Consumption： <300KW

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Sunway Bluelight

- National Engineering Center for Parallel Computer
- Developed for the National Supercomputing Center (Shandong), Jinan, China
- Peak performance of **Petaflops**
- Multi-core Processor designed by China
- Infiniband QDR 40Gbps
- Will be released on HPC China 2011@Jinan (Next Month)

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International Workshop on CO-DESIGN

October 25-26, 2011, Beijing, China

http://www.ncic.ac.cn/codesign/

You are welcome to participate!

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- Goal
  - broad discussions on domain applications requiring extreme scale computing systems and the path to co-designs with petaflops supercomputers, the new challenge and opportunity ahead in the design and development of simulation software.
- Topics
  - Finite element/generalized FEM/particle/meshfree methods, numerical simulation and software
  - Parallel computing in engineering and science
  - GPGPU accelerated numerical analyses
  - Highly scalable numerical methodologies
  - Fault tolerant numerical analysis
  - Mixed precision scientific computing
  - Real-time simulation and computational reality
  - Experience and vision on petascale computing

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Thank you!

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