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About us: Tsinghua HPGC

The Tsinghua High Performance Geo-Computing (HPGC) research group was founded in the year of 2011. The group has been led by Dr. Haohuan Fu, who worked in Tsinghua University as an associate professor since Dec, 2010.

As a computer scientist who has been working in the geoscience domain for years, Dr. Fu set up the group to promote the fusion of HPC technologies and geoscience applications, and to provide training and education for postgraduate students that would develop knowledge and expertise in computer science, computational mathematics, and geoscience.

The methodology that the HPGC tries to develop is to tackle research and engineering challenges from a combined perspective that consists of the geo-science application at the top, the numerical algorithm in the middle, and the hardware architecture at the bottom. Through a systematic approach that tries to arrive at the optimal option from all three different angles, we are striving to provide the best HPC solution for various geoscience applications.

While the group is relatively young, it has been growing fast in these years. With 3 students to start with, the group currently includes 17 young and passionate research students, of which 7 are PhD candidates, 6 are Master candidates, and 4 final year undergraduates who would join the group in the next semester. While the current research activities cover a wide spectrum of topics (geophysics exploration, climate modeling, data mining for geo-scientific data, water plant layout planning, etc.), the focus has always been applying HPC technology to accelerate the computation, the data analysis, and even the new scientific discoveries in corresponding domains.

清华大学 HPGC 研究组介绍

清华大学高性能计算地球科学研究组成立于 2011 年。该研究组在清华大学副教授付昊桓博士的指导下展开工作，并取得众多优秀成果。

作为一名长期工作于地球科学领域的计算机研究人员，付昊桓博士成立 HPGC 研究组的目的在于促进高性能计算技术与地球科学应用的有效结合，并培养大量在计算机科学、计算数学以及地球科学领域拥有丰富知识与专业技能的研究生。

HPGC 研究组凭借将顶层的地球科学应用，中间的数值计算算法以及底层的计算架构相融合的综合性方法，来应对来自研究领域或工程实现过程中的各种挑战。通过从上述三个不同方面综合考虑，为各种地球科学应用设计和实现最佳的高性能计算解决方案。

虽然 HPGC 研究组相对比较年轻，但是在近几年却获得了非常快速的发展。该组创建时仅有 3 名同学，短短 3 年之后，这里就拥有了 17 名年轻又充满激情的学生，其中包括 7 名博士研究生，6 名硕士研究生以及 4 名即将入学的大四本科生。虽然目前研究组涉及的领域非常广泛（包括地球物理勘探、气候模拟、地球科学方面的数据挖掘、自来水厂布局规划等），但是我们研究的焦点一直是如何使用高性能计算技术来加速相关领域中的计算、数据分析甚至新知识探索等过程，以求获得更好的性能，为科研以及产业界带来更高的价值。

Annual Meeting 2014/2014 年会介绍

Since its foundation in the year of 2011, the HPGC group has been growing steadily in both its size and research. As the HPGC group focuses on high performance computing applications in geoscience domains (especially geophysics exploration), the collaboration with both the oil and gas industry, and the HPC industry, has always been a key element in the long-term development.

To further promote the knowledge exchange between the academic and the industrial community, we are organizing the first annual meeting of the HPGC group in this year.

Our goal is to have a long-term forum that could bring talents from both geoscience domains (focusing on oil and gas) and computer science domains together, and come up with solutions to tackle the current challenges from both algorithmic and architectural perspectives. Ideally, the forum could also serve as the idea exchange site between the university side and the company side, between the students and the industrial leaders.

从 2011 年成立以来，HPGC 研究组在规模以及科研进展方面都获得了稳定而快速的发展。HPGC 研究组致力于地球科学领域内的高性能计算（尤其是地球物理勘探方面）研究。与石油以及高性能计算等领域的工业界开展充分合作，是研究组长期发展的关键因素。

为了能够进一步促进学术界与产业界之间的交流与合作，更好地探讨相关知识与技术，我们在今年组织和举办 HPGC 研究组的首次年会。

我们的目标是建立一个长期的论坛，使得来自地球科学领域和计算机技术领域的人才能够很好的交流与合作，从而能够综合算法和架构两个方面来提出更优化的计算解决方案。我们也期望，该论坛能成为科研领域与工业领域充分交流的平台，在这里学生和业界领袖能够更好的交换彼此看法，达到地球科学与计算科学更加紧密结合的目的。

Meeting Agenda/会议日程

15th May , Thursday	
Time	**Session**
14:00 - 17:30	Registration
17:30 - 18:30	Ice Breaker and Meeting Preview
18:30 - 20:30	Buffet Dinner
16th May , Friday	
Time	**Session**
07:00 - 08:30	Breakfast
08:40 - 08:45	Opening Speech, Prof. Guangwen Yang
08:45 - 09:20	"HPGC 2011-2014: An Overview", Dr. Haohuan Fu
09:20 - 09:50	Keynote Speech, "HPC in oil and gas: Past, present, and future", Dr. Robert G. Clapp, SEP, Stanford University
09:50 - 10:50	Oil and Gas Industry Session (Aramco and Schlumberger): "Our Current Needs for HPC", Dr. Yi Luo, Saudi Aramco "Introduction of Schlumberger", Dr. Yong Wang, Schlumberger
10:50 - 11:10	Coffee Break

11:10 - 12:00	Computation Acceleration for Geoscience Applications I "Solving atmospheric equations through heterogeneous platforms", Lin Gan + Jingheng Xu "A parallel finite-element time-domain method for transient electromagnetic simulation",Yingqiao Wang + Jiarui Fang "Using HPC to Plan a City Like Beijing", Junfeng Liao
12:00 - 13:30	Lunch Break
13:30 - 14:20	Computation Acceleration for Geoscience Applications II "Tuning Extremely-Complex Stencils for Elastic Wave Modeling on GPUs",ZihongLv "Can GPU bring us an interactive BEAM engine?",Conghui He + Weijie Zheng "A Clever Way to do Ray Tracing in Beam Migration", Mengyao Jin + Bangtian Liu
14:20 - 15:20	HPC Industry Session (Maxeler, NVIDIA, Inspur): "Computing appliances as new technology direction", Diego Oriato, Maxeler "GPU for oil & gas", Zehuan Wang, NVIDIA "GPU and MIC Technology Accelerate Oil Applications", Qing Zhang, Inspur
15:20 - 15:40	Coffee Break
15:40 - 16:10	Algorithm Development "EnKF based crossing subspace optimization for hyper-parameters in machine learning", Yushu Chen "Reflection and Travel Time Full Waveform Seismic Inversion with a High Performance Solution",Tengpeng Wei
16:10 - 17:00	Data Mining "Probabilistic Graphical Model and FPGA-based Acceleration", Wenlai Zhao "MIC-SVM: Efficient Support Vector Machines for Multi-Core and Many-Core Architectures", Yang You "FPGA-based Design of Convolutional Neural Network", Zhihui Xue, Jiahe Liu

17:00 - 18:00	Discussion and Wrap Up
18:30 - 20:30	Dinner
17th May , Saturday	
Time	**Session**
09:00 - 12:00	Group Activities (TBA)
12:00 - 13:30	Lunch

Keynote

Speaker: Robert (Bob) G. Clapp, Stanford University

BIO

Bob Clapp is a renowned geophysical researcher at Stanford University. A 2007 recipient of the SEG's J. Clarence Karcher Award, Bob has spearheaded an array of technical innovations during his tenure at Stanford. One of the first to successfully implement a 3D reflection tomography algorithm, Bob has gone on to make significant contributions in wave equation migration, automated seismic interpretation, parallel computing, and large-scale visualization, among other things.

Title: HPC in oil and gas: Past, present, and future?

Abstract

Oil and gas has historically been a big player in high performance computing (HPC) from main frames in the sixties to clusters of tens of thousands of nodes, often with GPUs, now. Through all this time the goal has remained the same: make the most accurate picture of the subsurface and how it might act given some new inputs. The goal might have stayed the same but the methods used to achieve this goal have changed substantially, often brought on by the hardware available at a given time. Each substantial hardware advancement requires a reassessment of what is "fast" and what is "slow", often requiring significantly different approaches. In the next few years we face another significant change with the introduction of 3D memory (and the interconnect possibilities associated with it). With this change we are sure to see new winners and losers, both in algorithms and architectures. In this talk I will go over some of the past architectural/algorithmic tipping points and hypothesize what we might see in the future.

Industry Talks

✧ *Saudi Aramco*

BIO

Yi Luo

1998 - now for working Saudi Aramco;

1991-1998 for Chevron,

1988 - 1991 PhD in University of Utah.

In addition, Yi Luo received his BS and MS from Chinese university of science and technology and Chinese academy of science in 1982 and 1985.

Title: Our current needs for HPC

Abstract

In this talk, Yi will present three topics: reverse time migration, multiple reduction and automatic fault extraction. For these topics, resident progresses and computational challenges will be addressed.

✧ *Schlumberger*

BIO

Wang Yong:

Schlumberger Software Métier Manager in Beijing Geoscience Center.

PhD, graduated from Peking University in 2003.

Title: Introduction of Schlumberger

Abstract

Overview of Schlumberger's business and introduction of Beijing Geoscience Center. Schlumberger's vision of high performance computing in cloud.

✧ Maxeler

BIO

Diego Oriato is lead architect at Maxeler Technologies. He brings many years of experience in software development of large web applications with in depth knowledge in the field of performance optimization. Recent work on high performance computing of seismic and meteorological application has lead to several publications such as the "Acceleration of a Metereological Limited Area Model with Dataflow Engines, 2012 SAAHPC" and "Acceleration of the anisotropic PSPI imaging algorithm, SEG 2012".

Title: Computing appliances as new technology direction

Abstract

General purpose computing architectures are struggling to keep up with data and speed requirements of modern applications. Physical issues such as power consumption and heat dissipation are severely limiting the technology. But while custom ASICs are a suitable answer for established algorithms such as bitcoin miners, in the O&G arena application-specific integrated circuit are almost unheard of; this because of the changeable nature of algorithms and the difficulty of programming hardware. Maxeler Multiscale Dataflow computing bridges software and hardware by keeping the flexibility of software and the raw performance of custom hardware. This approach has been proven successful already in several O&G companies and on many different applications. As data volumes grow further and new algorithms are developed with almost real time constraints, dataflow computing combines software and hardware in a single appliance capable of delivering fast performance, small form factor, low energy consumption, low maintenance and suitable for field deployment.

✧ NVIDIA

BIO

Zehuan Wang graduated from Beijing University of Posts and Telecommunications with a Master degree. He joined NVIDIA in 2012 and has been working as the HPC developer technology engineer. His major responsibility is multimedia and intelligence video analysis. He participates in many GPU projects of video analysis, molecular dynamics, information security and biometrics identification.

Title: GPU for oil & gas

Abstract

The report begins with a brief introduction of GPU, including basic knowledge of GPU architecture and the concept of GPU Heterogeneous computing. It then focuses on the implementation of the important algorithm of oil & gas on GPU. It ends with a summary of the GPU’s contribution to oil & gas program.

✧ INSPUR

BIO

Qing Zhang, working in HPC business, Inspur, Inspur-Intel China Parallel Computing Joint Lab Chief Engineer, high performance computing application development manager, engaged in the high performance computing,parallel computing research and have participated in many CPU+GPU and CPU+MIC collaborative computing research projects, such as BLASTN, PSTM, RNA, and so on. He has rich GPU and MIC development experience in biological information, oil, CFD， etc. The author of the book "MIC High performance Computing programming guide".

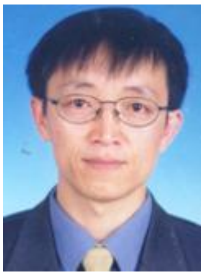
Title: GPU and MIC Technology Accelerate Oil Applications

Abstract

Tianhe-2 and Titan heterogeneous systems rapidly promote the development of the HPC applications.GPU and MIC heterogeneous computing gradually become the mainstream of computing model. Some high parallel, compute-intensive oil applications, such as mass migration computing, denoising computing and attribute extraction will be very suitable for GPU and MIC.GPU and MIC also faces parallel algorithm, programming efficiency, big data and IO challenges.

HPGC Group Member/ HPGC 小组成员介绍

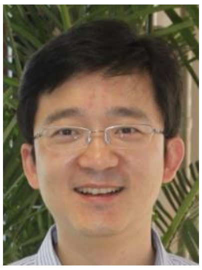
Steering Committee of HPGC:



Prof. Guangwen Yang (Director)

Head of the HPC Institute and the Ministry of Education Key Laboratory for Earth System Modeling in Tsinghua University

Committee member of the HPC (2002-2011) and China Cloud (2011-now) advisory board of the National 863 Project



Dr. Xiaomeng Huang

Associate professor in the Center for Earth System Science in Tsinghua University

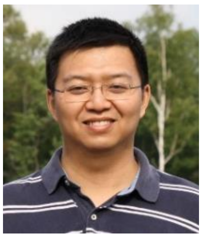
Deputy Director of the Ministry of Education Key Laboratory for Earth System Modeling in Tsinghua University

Dr. Wei Xue

Associate professor in the Department of Computer Science and Technology, Tsinghua University

Jointly appointed associate professor in the Center for Earth System Science

Faculty:



Dr. Haohuan Fu

Associate professor in the Center for Earth System Science in Tsinghua University

Founder and principal investigator of the HPGC group

Postdoc (2009-2010), Stanford University

PhD (2005-2008), Imperial College London

MPhil (2003-2005), City University of Hong Kong

Bachelor (1999-2003), Tsinghua University

3rd Year Students:

Lin Gan

PhD Candidate (2011 -): Department of Computer Science and Technology in Tsinghua University

Bachelor (2007-2011): Beijing University of Posts and Telecommunications

- **Research Interests**
  - Applications acceleration through hybrid algorithms and heterogeneous platforms
  - Atmospheric modeling based on different HPC platforms

- **Research Highlights:**
  - A Peta-Scalable Atmospheric Algorithm On Hybrid CPU-GPU platforms

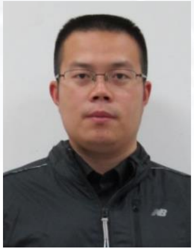
Atmospheric simulation is one of the major applications that run on the world's largest supercomputers. However, the complicated algorithms and heavy communications make it difficult to scale the performance on large-scale clusters. To solve the problem, we propose a hybrid domain decomposition methodology that can efficiently employ both the CPU processors and the GPU accelerators. Using this method, we achieve a sustained performance of 809 PFlops in double precision on the TH1A supercomputer.

  - Accelerating Solvers for Global Atmospheric Equations through Mixed-precision Data Flow Engines

Reconfigurable platforms such as FPGAs have showed a great potential in many key applications. We accelerate the global Shallow Water Equations based on a hybrid CPU-FPGA platform. Through mixed-precision arithmetic, we manage to build the resource-demanding kernel into a single FPGA card, and achieve magnitude of improvements on both the performance and power efficiency.

  - A Highly-Efficient and Green DFE for solving Euler Atmospheric Equations.

3D Euler equations are the most essential equations that describe the mesoscale atmospheric dynamics. In this work, we apply optimizations based on algorithmic offsetting and fast memory table, and manage to decrease more than 50% of the resource requirement. A deep computing pipeline is deployed and a significant performance improvement is achieved.

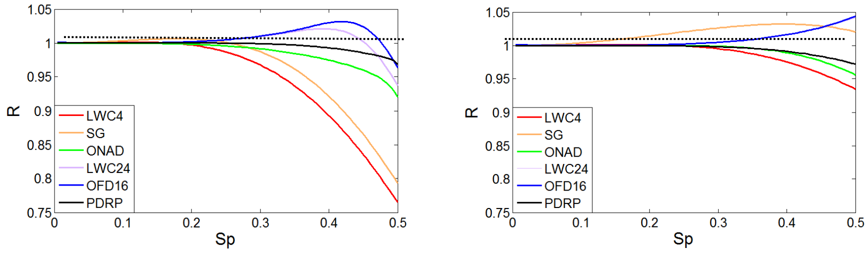


Yushu Chen

PhD Candidate (2011 -): Department of Computer Science and Technology in Tsinghua University

- **Research Interests**
  - Seismic forward modeling
  - Data assimilation of earth system models
  - Machine Learning (SVM, ANN)
- **Research Experience**
  - A polynomial-constrained dispersion-relation-preserving (PDRP) scheme in Seismic forward modeling

The PDRP scheme is a finite difference method for wave equation. The key element of PDRP is a spatial differentiator derived by combining the polynomial constraints and the wavenumber domain optimizing on wave-fields represent by wave displacements and their gradients. PDRP is effective to suppress both the numerical dispersion and the numerical error. In both of the two aspects, PDRP outperforms traditional high order finite difference schemes .e.g. the spatially 24th-order accuracy Lax-Wendroff correction method (LWC24). To generate clear wave fields, its computational efficiency is 227% comparing to LWC24.



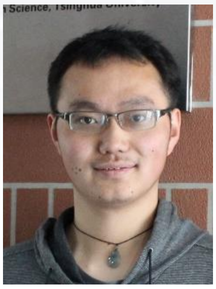
The numerical dispersion relationship of PDRP, LWC4,LWC24,SG and OFD16.

- Data Assimilation

We developed a data assimilation system for the FGOALS_G2 earth system model based on the ensemble Kalman filter (EnKF).

- Machine Learning (SVM, ANN)

I proposed an enhanced support vector machine (SVM) by EnKF and a fast training method for recursive neural network training by split updating steps.



Wenlai Zhao

PhD Candidate (2011 -): Department of Computer Science and Technology, Tsinghua University

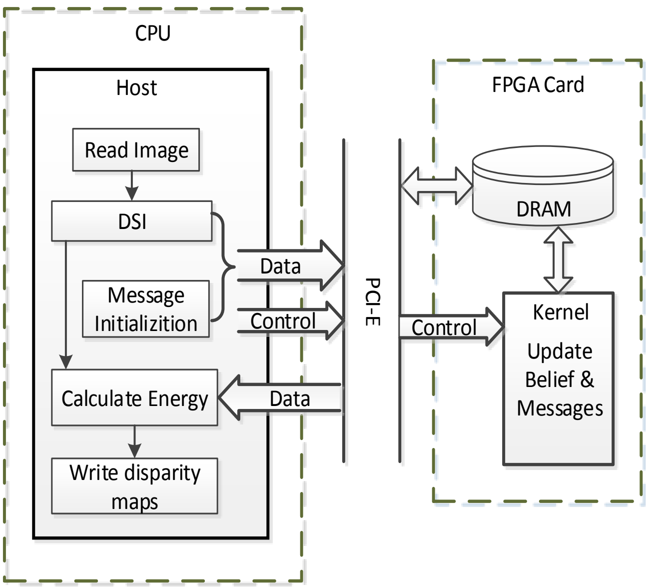
Bachelor (2007 - 2011): Department of Computer Science and Technology, Tsinghua University

- **Research Interests**
  - Applications acceleration on multi-core heterogeneous platforms
  - Probabilistic graphical model for computer vision and data mining
- **Research Experience**
  - Real-time HEVC (High Efficient Video Coding) decoder on ARM architecture mobile devices

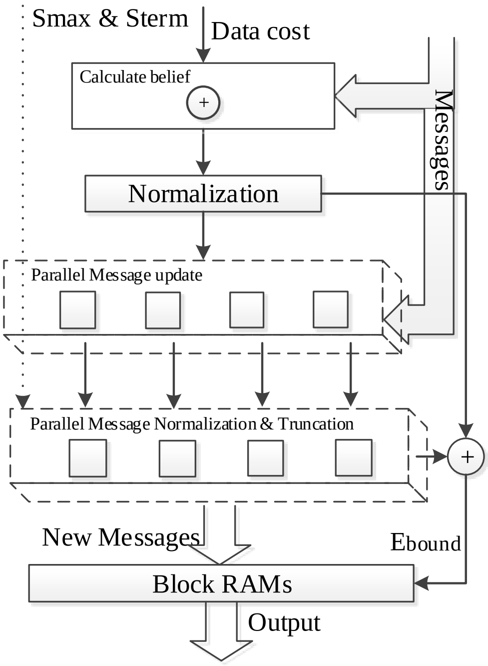
    HEVC is a new video coding standard, which doubles the data compression ratio and involves much more computational costs in both encoder and decoder. I proposed a real-time HEVC decoder on ARM architecture mobile devices (iPad) for 480p video, achieving 10 times speedup than the HEVC reference software.
  - FPGA acceleration of MRF (Markov Random Field) inference algorithm

    MRF is one of the probabilistic graphical models mostly used in computer vision. I proposed a fully-pipelined FPGA kernel for one of the MRF inference algorithms (tree-reweighted message passing algorithm) and build a hybrid CPU/FPGA system based on the kernel for stereo matching application. The hardware design achieves 100 times speedup over software implementation.

Architecture of CPU/FPGA System



FPGA Kernel



Tengpeng Wei

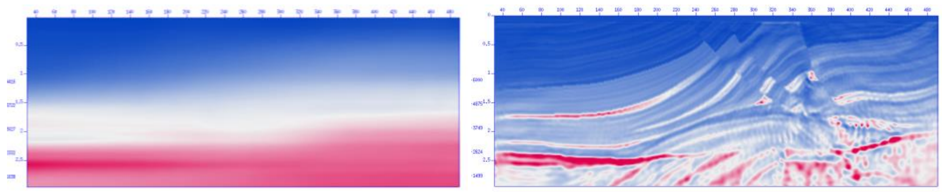
Master Candidate (2011 -): Department of Computer Science and Technology, Tsinghua University

Bachelor (2007-2011): Department Physics, Tsinghua University

- **Research Interests**
  - Exploration Geophysics, especially on the migration and Inversion methods
  - High Performance Computing for geophysical applications
- **Research Experience**
  - High performance Library for acoustic Forward Modeling, RTM and FWI

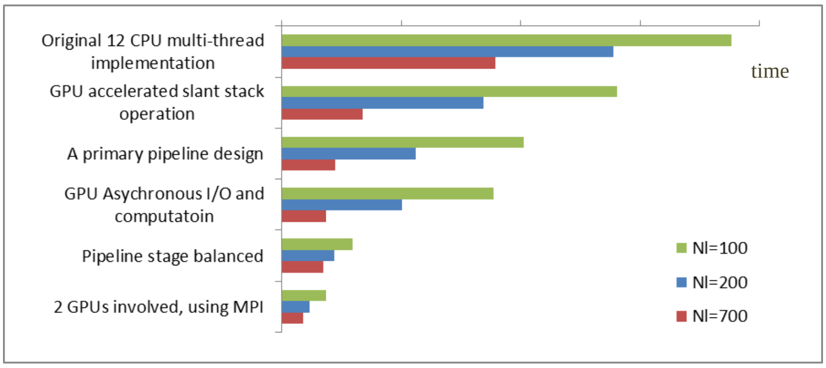
Based on an extensive study on the acoustic forward modeling methods, absorbing boundary conditions methods, RTM and FWI algorithm optimization strategies, a high performance library was developed to offer MPI, multi-core and GPU interfaces, and initiated to assist large scale seismic data processing experiments.

Initial model ***Reverted model***



- Accelerating the Data Pre-Processing in Beam Migration on a CPU-GPU Hybrid Platform

This project targeted at developing an interactive subsurface imaging method by taking full advantage of the CPU-GPU hybrid platforms. Optimization strategies include exploiting GPU kernels for computational-intensive slant-stack operation and a pipeline design for overlapping I/O transferring, CPU and GPU computation. We achieved over 10x speedup over an original multi-thread CPU implementation.



Yingqiao Wang

Master Candidate (2011 -): Department of Computer Science and Technology in Tsinghua University

Bachelor (2007-2011): Department Physics in Tsinghua University

Research Interests

- Multi-core parallel computing
- Program acceleration on FPGA
- GPU parallel computing and optimization

Research Experience

- Slant-stack acceleration in beam migration on GPU

High speedup is gained by transporting the hotspot into GPU. Moreover, a pipeline scheme is adopted to overlap different phases of the application, especially I/O.

- Parallel finite-element time-domain method for Transient Electromagnetic Simulation for marine petroleum exploration

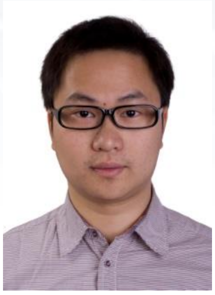
Finite difference approach in time domain (FDTD) is widely used to perform transient electromagnetic simulation. Compared to traditional FDTD, the finite-element time-domain (FETD) method with unstructured meshes and an adaptive time-stepping scheme has the potential to cut down both the number of unknowns and the number of time steps dramatically. However, the FETD method is generally difficult to parallelize because it requires solving a large-scale unstructured sparse matrix at every time step.

To make efficient utilization of multi-core computing resources, we design a parallel FETD method. In this method, a customized parallel incomplete Cholesky preconditioner is designed to accelerate PCG convergence.

To achieve more speedup of the total calculation time, two optimization schemes are adopted to gain more performance benefit. One is overlapping preconditioner calculation and PCG iteration. The other is reusing preconditioner.

The overlapping scheme executes the solver computation and the preconditioner computation at the same time using different amount of parallel resource. It aims to balance the different scalabilities of the solver and the preconditioner.

The preconditioner reusing scheme reduces the need to re-compute preconditioners when doubling the time steps in the later stage of the simulation. It brings performance benefit by reducing the frequency of less-scalable preconditioner computation.



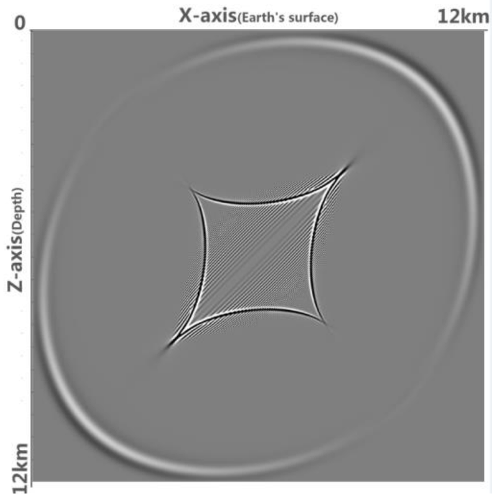
Zhihui Xue

Master Candidate (2011 -): Department of Computer Science and Technology in Tsinghua University

Bachelor (2007-2011): Beijing University of Posts and Telecommunications

- **Research Interests**
  - Multi-core and Many-core parallel computing, Multi-Node Cluster computing
  - Machine Learning (CNN,RNN,SVM)
  - Oil Exploration (NAD,RTM,TTI)
- **Research Experience**
  - High accuracy wavefield simulation in TTI media

Tilted transversely isotropic (TTI) media approximate the under-earth structures more accurately. To simulate the qP wave in TTI models more efficiently, we introduced the WNADM method, which is effective to suppress the numerical dispersion on a coarse grid. The WNADM is 3.2 times faster than the forth-order LWC scheme, generating wave field snapshots without any visible numerical dispersion.

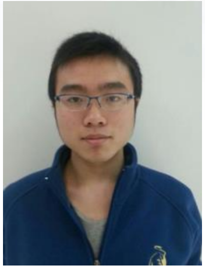


Wavefield snapshot of qP wave in TTI media with WNAD

- Accelerating CNN (Convolutional Neural Network) on FPGAs

CNN is one of the most commonly used algorithms in deep learning methods. According to the characteristics of CNN, we design a FPGA design with deep pipeline. In LeNet text, we get a speedup of 4.7 times faster than single GPU version (Caffe) with the same accuracy.

2nd Year Students:



Junfeng Liao

PhD Candidate (2012 -): Department of Computer Science and Technology in Tsinghua University

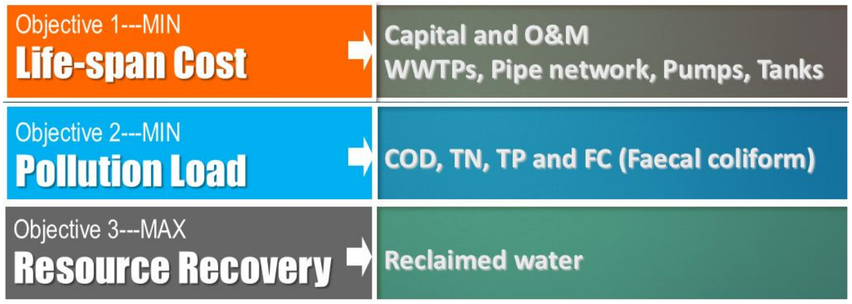
Bachelor (2008-2012): Department of Computer Science and Technology in Tsinghua University

- **Research Interests**
  - High performance computing in Urban planning model (URL, SWMM)
- **Research Experience**
  - **U**rban Wastewate**R** System **L**ayout Model

The urban wastewater system is one of the most important infrastructures for developing a sustainable city. Existing urban wastewater system is designed by planners' experience and simple qualitative analysis, such as the number of wastewater treatment plants (WWTPS) and their service areas.

In response to urban development, population growth, and diminishing natural resources, URL is designed as a spatial multi-objective optimization model with an integrated consideration of pollution, source reuse and costs.

With optimization and parallelization, a high performance is gained and the test data scale is increased from 40 areas in Beijing to 8000 areas in Hefei.



The three object of URL

- 3D Euler model

As global warming has become a pivotal environmental and social issue of the 21st century, large numerical models have become an indispensable tool for climate science. While climate model call for an increase of several orders of magnitude in the computing power, most existing global climate models are still struggling with the poor scalability and the inability to use many-core accelerators, such as GPUs or MICs, in current heterogeneous supercomputers.

The 3D Euler model extended from SWEs, has been work successfully on various kinds of platforms, such as GPUs, MICs and FPGAs. My current work is integrate the 3D Euler model into WRF as its dynamic core and make it work well.

Zihong Lv

Master Candidate (2012.09 -): Computer Science and Technology in Tsinghua University
Bachelor (2008.09 - 2012.07): Computer Science and Technology in Tsinghua University

Research Interests

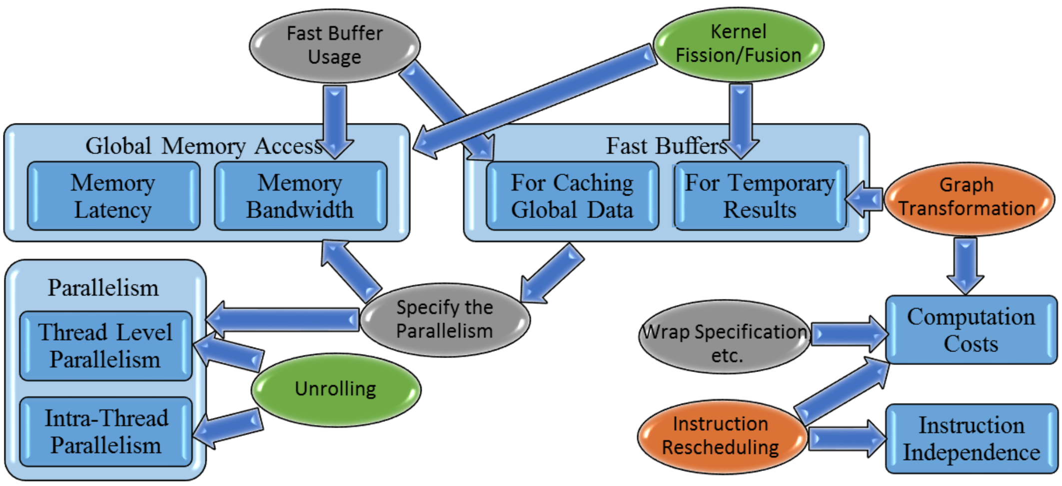
- Optimization techniques on Many-core and data-flow architectures
- Numerical Computation (Stencils) and Machine Learning (Support Vector Machine, Probabilistic Graphical Model)

Research Experience

- Optimization and Tuning Techniques for Extremely-Complex Stencils on GPUs

A typical example of extremely-complex stencils is the high-order stencil for simulating elastic waves in the isotropic medium, which generally involves hundreds of variables and thousands of operations for updating each grid point. A very limited effect is exerted on these complex stencils by previous optimization techniques, so we explore novel techniques especially designed for complex stencils.

Besides optimization techniques for normal stencils, we further include graph-oriented code transformation and scheduling of instructions into form a unified work flow to balance the utilization of various system resources and achieve the best possible performance. We search for the balanced combination on register usage and computation amount by extracting and transforming the expression graph of the original program. Automated instruction re-scheduling is utilized to improve instruction-level parallelism.



Optimization and Tuning Workflow

Yang You

Master Candidate (2012 -): Department of Computer Science and Technology in Tsinghua University

Bachelor (2009 - 2012): China Agricultural University

- **Research Interests**
  - Multi-core and Many-core parallel computing (e.g. CPUs, GPUs, MIC), Multi-Node Cluster computing
  - Machine Learning (SVM, ANN), Graph Algorithms (BFS), and Numerical Computation (Stencils, SpMV)

- **Research Experience**
  - MIC-SVM: Efficient Support Vector Machines for Multi-Core and Many-Core Architectures

Support Vector Machine (SVM) has been widely used in data-mining and Big Data applications as modern commercial databases start to attach an increasing importance to the analytic capabilities. In recent years, SVM was adapted to the field of High Performance Computing for power/performance prediction, auto-tuning, and runtime scheduling. However, even at the risk of losing prediction accuracy due to insufficient runtime information, researchers can only afford to apply offline model training to avoid significant runtime training overhead. Advanced multi- and many-core architectures offer massive parallelism with complex memory hierarchies which can make runtime training possible, but form a barrier to efficient parallel SVM design.

To address the challenges above, we designed and implemented MIC-SVM, a highly efficient parallel SVM for x86 based multi-core and many-core architectures, such as the Intel Ivy Bridge CPUs and Intel Xeon Phi co-processor (MIC). We propose various novel analysis methods and optimization techniques to fully utilize the multilevel parallelism provided by these architectures and serve as general optimization methods for other machine learning tools.

MIC-SVM achieves 4.4-84x and 18-47x speedups against the popular LIBSVM, on MIC and Ivy Bridge CPUs respectively, for several real-world data-mining datasets. Even compared with GPUSVM, run on a top of the line NVIDIA k20x GPU, the performance of our MIC-SVM is competitive. We also conduct a cross-platform performance comparison analysis, focusing on Ivy Bridge CPUs, MIC and GPUs, and provide insights on how to select the most suitable advanced architectures for specific algorithms and input data patterns.

1st Year Students:

Conghui He

PhD Candidate (2013 -): Department of Computer Science and Technology in Tsinghua University

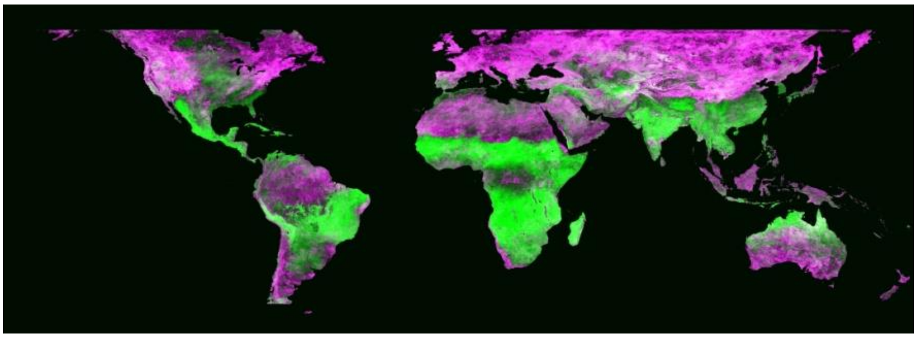
Bachelor (2009 - 2013): Software Engineering in Sun Yat-sen University

- **Research Interests**
  - Multi-core parallel computing, FPGA/GPU acceleration
  - Seismic Exploration and Imaging methods including Kirchhoff, BEAM, RTM, FWI etc
- **Research Experience**
  - Accelerating the Interactive Beam Migration on a CPU-GPU Hybrid Platform

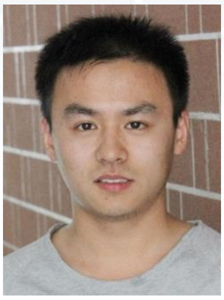
This project is aiming at developing a faster Beam migration algorithm by taking full advantage of computational capacity from CPU-GPU hybrid platforms. By applying some optimization strategies, including pipeline design for overlapping I/O transferring, decompressing the slantstack data on the fly and exploiting GPU kernels, the well-formed application gain over 20x speedup over the original implementation.

  - Accelerating the Global Vegetation-Precipitation Correlation Algorithm

Startup Project for PhD candidate cooperated with a Professor in Remote Sensing field, aiming to accelerate the algorithm taking months to finish. Optimization strategies for it includes modifying the algorithm to reduce I/O accessing by utilizing local buffer, adding a memory pool to reduce frequent memory allocation/destruction, overlapping I/O transferring and computing. It gained 20x speedup in the end.



Global vegetation-prediction response



Weijie Zheng

PhD Candidate (2013 -): Computer Science and Technology in Tsinghua University

Bachelor (2009 - 2013): Mathematics and Applied Mathematics in Harbin Institute of Technology

- **Research Interests**
  - Data Assimilation
  - Algorithm Optimization
  - Seismic Exploration and Imaging Methods including Kirchhoff, BEAM, FAST BEAM, etc

- **Research Experience**
  - Boundary Value Methods)BVMs(for delay differential equations with piecewise continuous arguments(EPCA)

BVMs have advantages over the linear multistep methods on stability and convergence, when used to solve the differential equations. And EPCA, one kind of differential equations, is widely applied as an important model in many fields, such as physical, biological systems and control theory.

The general format to solve EPCA via BVMs has been derived and the comparisons have been done with some other methods. Although the performance of BVMs is better than the linear multistep methods, its convergence order could not reach the theoretical one.

  - Suitable methods for parallel computing on ray tracing

Ray tracing is the essential part of some imaging methods such as Kirchhoff Migration. Based on the differential equations, some researchers simulate the propagation by solving these equations via Runge-Kutta methods or other methods. However, the strong data dependency, between the current step and the previous one in the iteration, makes it difficult to be parallelized on the GPU platform.

To solve the above problem, we explore possible algorithmic modifications to fit ray tracing into the GPU architecture.

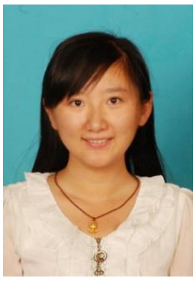
Bangtian Liu

Master Candidate (2013 -): Department of Computer Science and Technology in Tsinghua University

Bachelor (2009-2013): Huazhong University of Science and Technology

- **Research Interests**
  - Parallel computing based on Heterogeneous platforms such as GPU
  - Seismic exploration and imaging
- **Research Experience**
  - Optimization of Ray Tracing in Beam Migration on CPU and GPU Platform

The ray tracing process have two parts: Step tracer and Observer. Step tracer is to advance the simulation of all rays by one step. Observer is to observe the signal. In my work, I optimized the step tracer on both the hybrid CPU/GPU platform. In the current design, we achieve 10x speedup on one Nvidia Tesla K20c GPU over 16 Intel Xeon E5-2680 CPU cores.



Mengyao Jin

Master Candidate (2013.09 -): Computer Science and Technology in Tsinghua University

Bachelor (2009.09 - 2013.07): Telecommunication Engineering in Beijing University of Posts and Telecommunications

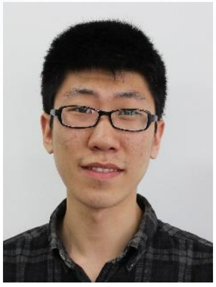
- **Research Interests**
  - Seismic exploration and imaging methods
  - High performance computing based on the application of Geophysics and Atmospheric chemistry
- **Research Experience**
  - The Ray Tracing Process in Seismic Exploration Parallelization and Performance Optimization on the GPU platform

The ray tracing process in seismic exploration consists of two parts: the StepTracer to make all rays take a step forward and the Observer to calculate the travel times. I have made efforts to parallelize the Observer process on GPU platform and optimize the performance.

- GEOS-Chem Atmospheric Chemistry Model Parallelization and Performance Optimization on the GPU platform

GEOS-Chem is one of the most advanced global 3D chemical transport model for atmospheric composition in the world. I proposed a scheme to parallelize the chemistry process of the GEOS-Chem on GPU, obtained improved performance.

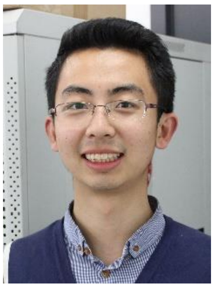
Final Year Undergraduates (join the group in the next semester):



Jiarui Fang

Bachelor (2010.09 -): Computer science in Beijing University of Posts and Telecommunications

- **Research Interests**
  - Marine oil exploration based on Finite Element Time Domain Method
  - Solving large-scale sparse linear equations on parallel platforms
  - Heterogeneous parallel programming algorithms based on GPU and CPU
- **Research Experience**
  - Parallel finite-element time-domain method for Transient Electromagnetic Simulation in marine petroleum exploration on GPU



Jingheng Xu

Bachelor (2010/09 – 2014/07): Computer Science and Technology in Sichuan University (Chengdu, Sichuan)

Exchange (2012/09 – 2013/06): Computer Science and Engineering in the University of Washington (Seattle, Washington)

- **Research Interests**
  - Multi-core parallel computing, GPU parallel computing and optimization
  - Heterogeneous parallel programming algorithms based on CPU, GPU, FPGA
  - High performance computing based on the application of Geophysics and Atmospheric chemistry
- **Research Experience**
  - Global Atmospheric Simulation Algorithm based on Heterogeneous Platforms

Jiahe Liu

Bachelor (2010.08 -): Software Engineer, Xi’an Jiaotong University

- **Research Interests**
  - High Performance Computing
  - Multi-core parallel computing, GPU parallel computing and performance optimization
  - FPGA parallel computing and performance optimization
  - Machine Learning and data mining.
- **Research Experience**
  - “A Discrete Region-based Approach to Improve the Consistency of Pair-wise Comparison Matrix” Fuzz-IEEE 2013
  - “Security Risks Evaluation Toolbox for Smart Grid Devices” SigComm 2013
  - FPGA-based Design of Convolutional Neural Network

Dajia Peng

Bachelor (2010.08 -): Department of Computer Science and Technology, Tsinghua University

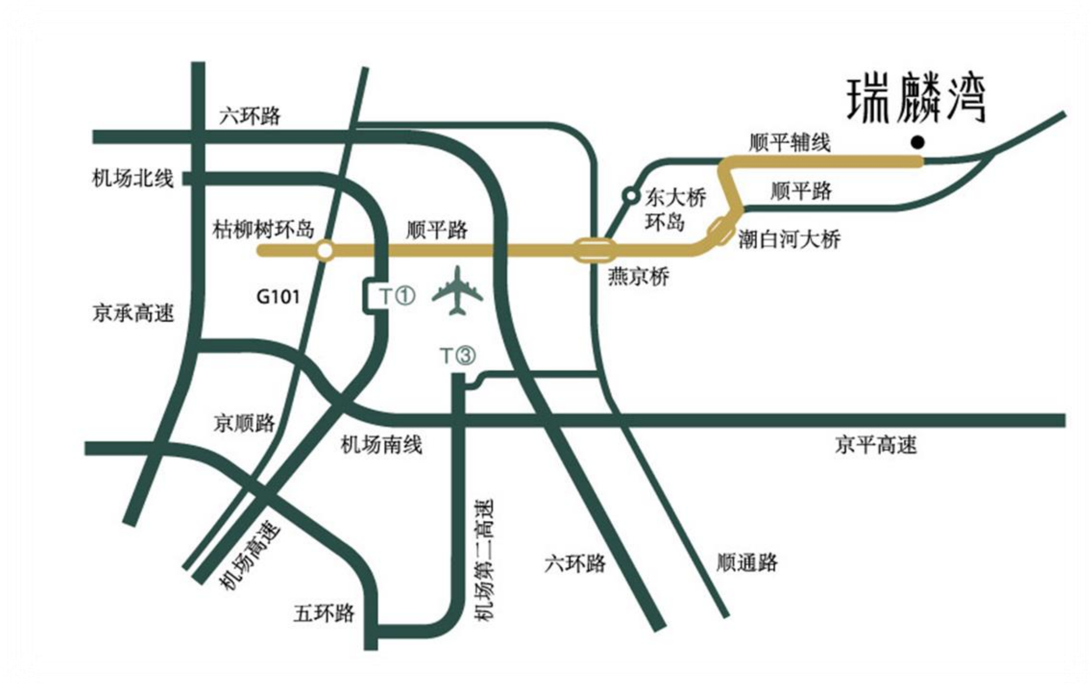
- **Research Interests**
  - High Performance Computing
  - Multi-core parallel computing, GPU parallel computing and performance optimization
  - Machine Learning, Recurrent Neural Networks Implementation on GPU
- **Research Experience**
  - Recurrent Neural Networks Implementation and performance optimization on GPU platform

Conference Venue/会议地点介绍

Ry lin won resort and spa is a five-star standard green eco spa resort hotel located in Shunyi District. The hotel and the park cover an area of 3,000 acres, greening rate of 70%. It integrates spa, rooms, catering, conference, entertainment and leisure as one resort garden.
Nearby spots include Beijing Qiao Bo Ski Resort, Beijing Countryside Racecourse, Beijing Olympic Happy Water World and Beijing Shun Li Xin Gaoliying tourism picking Park.

瑞麟湾温泉度假酒店是由北京市新天华业投资有限责任公司投资 5.5 亿打造的五星级标准的绿色生态温泉度假酒店，酒店位于北京市顺义区南彩镇顺平辅路 39 号箭杆河东侧，酒店及园区总占地面积为 3000 亩，酒店一期建筑面积约 6 万平方米，绿化率 70%以上。是集温泉、客房、餐饮、会议、娱乐休闲为一体的综合性园林度假酒店。

周围有北京乔波滑雪场，北京乡村赛马场，北京奥林匹克欢乐水世界和北京高丽营顺丽鑫观光采摘园等景点。



Address:

Shunpingfuxian No.39, Nancai Town, Shunyi District, Beijing

Phone:

010-89468899 to 8806/8809.

地址：

北京市顺义区南彩镇顺平辅线 39 号

电话：

010-89468899 转 8806/8809

Route：

Route 1: Airport Expressway → No.1 Airport Terminal → Airport North Line → Yanjing Bridge → Chaobaihe Bridge → Off the bridge, first traffic light turn left to the Zuodi Road → the first traffic light turn right to Shunpingfu road →straight 4 km.

Route 2: Jingshun Road → Kuliushu → Yanjing Bridge → Chaobaihe Bridge → Off the bridge, first traffic light turn left to the Zuodi Road → the first traffic light turn right to Shunpingfu road → straight 4 km.

Route 3: Jingcheng highway → Airport North Line → Shunping Road → Yanjing Bridge → Chaobaihe Bridge → Off the bridge, first traffic light turn left to the Zuodi Road → the first traffic light turn right to Shunpingfu road → straight 4 km.

Route 4: Tongzhou → Beiguan→ Yanjing Bridge → Chaobaihe Bridge → Off the bridge, first traffic light turn left to the Zuodi Road → the first traffic light turn right to Shunpingfu road → straight 4 km.

Route 5: No.3 Airport Terminal → toll station → see the crossroads turn right to Airport East Road → Yanjing Bridge → Chaobaihe Bridge → Off the bridge, first traffic light turn left to the Zuodi Road → the first traffic light turn right to Shunpingfu road → straight 4 km.

驾车路线：

线路一：机场高速→1 号航站楼→机场北线→燕京桥→潮白河大桥→下桥第一个红绿灯左转到左堤路→第一个红绿灯右转到顺平辅路→直行 4 公里路北既到。

线路二：京顺路 → 枯柳树环岛 → 燕京桥 → 潮白河大桥→ 下桥第一个红绿灯左转到左堤路→第一个红绿灯右转到顺平辅路→直行 4 公里路北既到。

线路三：京承高速 → 机场北线 → 顺平路出口出 → 燕京桥 →潮白河大桥→下桥第一个红绿灯左转到左堤路→第一个红绿灯右转到顺平辅路→直行 4 公里路北既到。

线路四：顺通线：通州 → 北关环岛 → 燕京桥 → 潮白河大桥→下桥第一个红绿灯左转到左堤路→第一个红绿灯右转到顺平辅路→直行 4 公里路北既到。

线路五：三号航站楼→过收费站→见十字路口右转→上机场东路燕京桥→潮白河大桥→下桥第一个红绿灯左转到左堤路→第一个红绿灯右转到顺平辅路→直行 4 公里路北即到

Other related information/会议相关事项

Registration / 会议注册

We set a Registration Desk in the lobby of the hotel, please register when you come, and get your room card as well as the conference manual.

会务组在酒店大堂设有注册台，请自驾的嘉宾到达酒店后在酒店大堂注册台处注册，领取房卡及会务手册。

Meals / 就餐

日期 Date	时间 Time	地点 Location	用餐形式 Dining Form
05 月 15 日 15th, May	18：30-20：30	巴萨西餐厅 Barca restaurant	中西自助 Buffet
05 月 16 日 16th, May	07：00-09：30	巴萨西餐厅 Barca restaurant	中西自助 Buffet
	11：30-13：30	亚泰餐厅 Asian restaurant	中泰自助 Buffet
	19：00-21：30	悦华厅 Yuehua Restaurant	中式桌餐 Chinese Banquet
05 月 17 日 17th, May	07：00-09：30	巴萨西餐厅 Barca restaurant	中西自助 Buffet

Weather In Beijing / 会议期间北京天气

Thursday May 15th	Sunny	16～29℃
Friday May 16th	Sunny	18～29℃
Saturday May 17th	Cloudy	15～25℃

15 日（星期四）	晴	16～29℃
16 日（星期五）	晴	18～29℃
17 日（星期六）	多云	15～25℃

Warmly Prompt / 温馨提示

1. There is a morning call at 7:30, 16th May, you can notify the front-desk to cancel it according to your demand.
2. We will take a meeting photo during the Afternoon-Coffee-Break on 16th May, please attend if you can.
3. During the buffets, meat and vegetable will be placed separately, please help yourself.
4. The hotel includes an excellent hot spring spa, please bring your own swimwear to enjoy.

1. 16 日早 7:30 会安排早叫服务，根据您的需要可通知前台取消。
2. 我们将在 16 日下午茶歇时安排合影，请您尽量出席。
3. 自助餐时肉类和蔬菜将分类摆放，祝您用餐愉快！
4. 酒店提供温泉服务，请自备泳具。

Contact of conference staff / 会务人员联系方式

路　雯 (Wen Lu)：+86 15901084190
赵文来 (Wenlai Zhao)：+86 13810359877
徐敬蘅 (Jingheng Xu)：+86 18653236889
刘加贺 (Jiahe Liu)：+86 13120361231
方佳瑞 (Jiarui Fang)：+86 13717819702

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