Asia HPC Overview – Exascale Perspective IESP

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Basis for our Analyses

ATIP is US non-profit focusing on tracking technology

 in Asia (many years)

Emphasizing on the ground staff and offices

   Japan, China, Korea, India,…

We believe to really understand more than surface-level issues requires long term day in day out access.

Plus willingness to act as colleague to expand areas of mutual benefit.

Reports, briefings, workshops, "tech tours,"…

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References – Reports including

ATIP12.009: HPC China 2011

ATIP12.008: Asian HPC Update: China, Japan, Korea

ATIP12.007: Software R&D in Dalian, China

ATIP12.006: Indian HPC Perspective

ATIP12.002: HPC in Taiwan

ATIP11.017: CPU Development Activities in China

ATIP11.008: HPC in China 2010 - 2011

ATIP11.003 Japan's Recent Progress and Transformation in HPC

ATIP11.002: ATIP's 2010 Workshop on HPC in China

ATIP10.022: HPC Researchers in China

ATIP10.007: HPC in China, Part Two: Applications and Trends

ATIP10.006: HPC in China, Part One: History and Current Status

ATIP09.021: HPC in Korea & National Research Foundation of Korea

ATIP09.020: HPC in India

ATIP09.019: Japan's Changing HPC Market

ATIP09.018: Cloud Computing in the Asia-Pacific

Japan-Asia HPC Digest (January-February 2012)

Japan-Asia HPC Digest (November-December 2011)

Japan-Asia HPC Digest (September-October 2011)

Japan-Asia HPC Digest (July-August 2011)

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WON'T REPEAT THAT
Instead – some general remarks

Major HPC Players

    China   ← (already discussed today, I'll add a few comments)

    Japan   [please ask the IESP participants]

Secondary

    India   ←

    Korea

    Taiwan

    Singapore ←

    Australia ←

Others

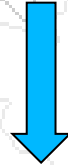   Vietnam, Malaysia, Indonesia, …

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China's HPC Situation vs US

THE WALL STREET JOURNAL
WSJ.com

Mar 23 2012 "China's Not So Super Computers"

I'm here

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China HPC: Big Picture

Building an HPC ecosystem

    Chips (but no fabs yet) to systems to customer channels

HW R&D

    Quality engineering

    No breakthrough architectural ideas

        Followers and adaptors thus far

System diffusion is significant, driven by government

SW R&D

    Significant domestic SW development (apps and system sw)

    Weakly diffused to the community

    Tools to develop major apps are weak

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China HPC

China now ranks second to the US in the number of systems on the TOP 500, including the #2 and #4 systems. Very rapid improvement over the past few years (see following slide).

Three more or less independent HPC efforts, CAS, NUDT, JiangNan Institute – last two related to defense community.

JiangNan remamed as National Research Center of Parallel Computer Engineering & Technology (NRCPCET)

Several Chinese HPC systems incorporate indigenous technology, and in particular BlueLight utilizes only Chinese CPUs.

FeiTeng (FT) 8-core processors (FT-1000) based on MIPS in Tianhe1A; Godson (or Loongson) 8-core processors (Godson 3B) based on SPARC in Nebulae; Sunway BlueLight, uses 8,704 Chinese Shenwei (SW) 16-core processors (SW-1600) roughly based on Alpha (1PF but also 2PF somewhere).

Government projects are targeting the development of application software that can scale up to nearly one million cores.

Installed Chinese HPC

Year		TOP 500 China Sum Peak GFLOP	A TOP 500 US Sum Peak GF	B China Top 100 Sum Peak GF	B/A Ratio (China's fraction vs US Peak)
2000			81,006		
2001		563	120,192		
2002		3,472	242,210	7,763 Top 50	3%
2003		18,482	530,841	33,975	6%
2004		54,347	1,119,880	90,617	8%
2005		101,137	522,894		
2006		122,934	3,325,500	319,186	10%
2007		155,856	6,240,242	527,186	8%
2008		844,192	17,454,022	1,682,125	10%
2009		2,536,415	24,187,603	3,829,980	16%
2010		11,609,730	31,483,946	12,517,591	40%
2011		19,377,900	46,630,500	20,994,571	45%

China is improving

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China

Half of China's Top 100 from domestic vendors (IBM=Dawning/Sugon=35%)

Belief of Chinese HPC leadership: (a) China only 2-3 years behind in core areas, except for apps. (b) Recognize that key research largely evolutionary based on Western designs.

Software apps being developed, with strong claims about technical capabilities, but weak transition to products.

Basic research in software and systems is improving, with more papers reaching international readers via conferences and journals.

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Trends: Utilization of GPUs; expansion of cloud services and cloud centers. Also, movement toward data-centric computing and services.

Central, city, & provincial governments support creation and expansion of SC centers for national, regional, local user needs, also to develop user interest in HPC.

Future plans -- HPC funding will continue. Emphasis: building capabilities of existing and some new centers to reach multiple-PFlops level (10PF soon). Also, there is increasing support for the creation of domestic software to replace international products, which are expensive and sometimes impossible to obtain.

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China HW

Prof. Zuonin CHEN (CAE) chief engineer of the National Research Center of Parallel Computer Engineering & Technology (NRCPCET) - developer of the Sunway BlueLight system called for the related research institutes that are developing processors (i.e., NUDT, ICT, and NRCPCET) to work together and build Chinese standard instruction sets.

"While China's self-defined instruction set is not necessarily incompatible with foreign ones, China needs to develop software and hardware standards based on a standard instruction set and promote the corresponding industry development."

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Chinese Academy of Science (CAS) Institute of Computer Technology (ICT), long viewed as the birthplace of Chinese HPC & maintaining the best research activities in country, will reorient its activities to focus more on high end technologies required by industry. ICT will also develop core technologies for future ExaScale systems.

Re ExaScale: Chinese are very pragmatic about this. Will monitor, keep involved, participate.

Predictions (Made April 2011)

- One system with peak performance of 10 Pflops will be built:2012-2013

- One system with peak performance of 100 Pflops will be built: 2014-2015

- Aggregate Linpack performance of Chinese Top 100: 10PFlops: 2011-2012

- Aggregate Linpack performance of Chinese Top 100: 100Pflops: 2013-2014

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Applications

Across the sector spectrum

Especially

Structures, EM, CFD, FEM, some bio

Fortran (F77, F90), MPI, C++

Platforms (fully integrated GUIs) just beginning to occur

Weaknesses: Limited usage outside local labs

Lack of sw and data management tools

Debuggers, compilers, organizers,…

Documentation

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Two widely used: SiPESC & JIFEX

Software Integration Platform for Engineering & Scientific Computation

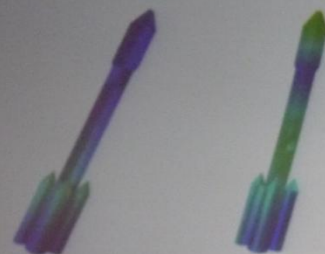JIFEX is FEM and structural optimization tool

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多重多级子结构的大规模计算思路
火箭结构算例

前十阶频率比较如下

No.	Jifex	Nastran	偏差
1	1.671956	1.672265	-0.02%
2	1.674505	1.672267	0.13%
3	4.226643	4.245021	-0.43%
4	4.244837	4.268734	-0.56%
5	4.279437	4.296137	-0.39%
6	4.308059	4.296147	0.28%
7	7.196274	7.207983	-0.16%
8	7.702368	7.711696	-0.12%
9	7.711293	7.711704	-0.01%
10	10.05816	10.07337	-0.1%

第一阶模态　　第二阶模态

第七阶模态　　第八阶模态

System Software

China has done a good job harnessing the power of Open Source.

Especially for Linux

Red Flag is largest

Sugon (Dawning) claims that Longteng servers have particularly high security, because its hardware and software are both home-developed. Prof. Guojie LI, member of Chinese Academy of Eng and Chinese govt's top advisor on HPC, said the advent of the Longteng server is helping promote the commercialization of the Loongson series CPU, and will drive related home-developed products including operating systems, middleware, database, and application software to establish China's own IT industry chain.

Without government support commercialization of either HW or SW will be challenging, especially if compatibility is an issue.

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BlueLight Apps

Application	# cores
Numerical weather forecasting model (WRF3)	12,288
Mid-scale numerical weather forecasting model (MM5)	11,520
Parallel ocean circulation model (POP)	24,000
3rd-generation ocean wave model (MSUMU-NWAM)	10,000
Large-scale parallel compressible fluid CFD software (MPCCFD)	32,768
Simulation of aircraft in the entire flying range (GKUFS)	80,750
Financial num analysis (MCPRICE)	131,072
Molecular dynamic simulation software (NAMD)	16,384
High-throughput drug screening software (DOCK)	11,000

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China New Govt Programs

MOST 863. RMB 1.2B (~US$190.3 million) + 600M for SW 2011~2015: two 100-PF systems by 2015 (by NUDT & ICT) to Guangzhou, Chongqing. Plus each local govt will match RMB 1.2B

Two separate sw projects for apps and pp development platforms

Fusion, aircraft design, spaceship, drug discovery, animation, structural analysis of large equipment, EM environmental simulation, new materials, RMB 10 million for each. Each package must scale to > 300,000 CPU cores with a parallel efficiency > 30%.

The second allocates RMB 20 million to structural mesh, non-structural mesh, non-mesh geometry, FEM. Apps must scale to > 900,000 CPU cores with parallel efficiency >30%. Proposals are presently under evaluation.

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China New Govt Programs

NSFC July 2011, 8-year major research plan for basic algorithm and computational modeling, RMB 180 million (~US$28.6 million). Emphasizing <u>mega</u> national demands as well as promoting the co-design of both hardware and software:

In 2011, RMB 37 million allocated for 25 projects, including 20 <u>fostering</u> projects RMB 600K – 900K for each for a three-year term, and five key projects with RMB 3-5 million for each project for a four-year term.

In 2012, RMB 40 million (~US$6.3 million) will be allocated to support about 25 fostering projects and six <u>key</u> projects. The grant size and length of term in 2012 are the same as in 2011.

Last Comments

China is investing resources toward developing an entire ecosystem / infrastructure in the IT and HPC space. This includes design of processors and other hardware, fabrication, supply chain, and system integration technologies.

SW remains weak but investments are being made.

China hopes that their HW &/or SW may eventually compete in markets now dominated by foreign vendors.

China's goal is not only to be more self sufficient and use HPC for their own needs, strategic, scientific, and commercial, but also to export their technologies, initially to countries in Asia, Africa, etc., and eventually even to the US and Europe. Admittedly, this goal may not be fully realized.

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India

Tried to develop parallel systems during the 1980s-1990s as a result of US export control restrictions.

Faded away between 2005-2010. Little interest now in domestic system building.

New efforts to obtain HPC systems commercially.

~US$1B proposed by PM (over 5 years) to be made available for HPC, beginning April 1 2012 (details unspecified at this time).

There is some talk about Exascale issues but at the moment there are no PF systems to extract experience from.

In virtually all aspects of HPC (HW & SW) India lags behind China.

Tata's CRL is the only HPC center in India providing technical service and cycles.

There are some interesting upcoming procurements (next slide)

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India's HPC Push

CSIR C-MMACS: ~300 TF (HPL) / 362 TF Peak HP system using Intel Xeon E5 with 2 PB storage from DDN.

VSSC, ISRO, is enhancing their GPU cluster, ~double present capacity which is 200 nodes with 2 GPUs each (special configuration)

Inter University Centre for Astronomy and Astrophysics, Pune has placed order for 30 TF HP system using Intel Xeon E5s.

IIT, Madras is procuring 2 systems, 40 TF from SGI and 80 TF from IBM with Intel Xeon E5s.

An Agricultural research org in Delhi has placed orders for large HPC systems

Aeronautical DevAgency (ADA) in Bangalore placing order for 32 node E5 cluster with 2 GPUs each.

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Korea/Taiwan

Korea:

Law in place stating need for HPC.

Restructuring, to generate a new committed national HPC center.

Taiwan: For the past 20 years, the primary goal for HPC development in Taiwan is promoting HPC applications, rather than building an HPC industry.

Show social need, not only (or even primarily) scientific need.

Emphasis on helping economic and industrial development

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Singapore

Currently has ~200TF capacity (NUS, NTU, A*CRC)

A*STAR plans to restructure efforts into a national HPC facility and double capacity.

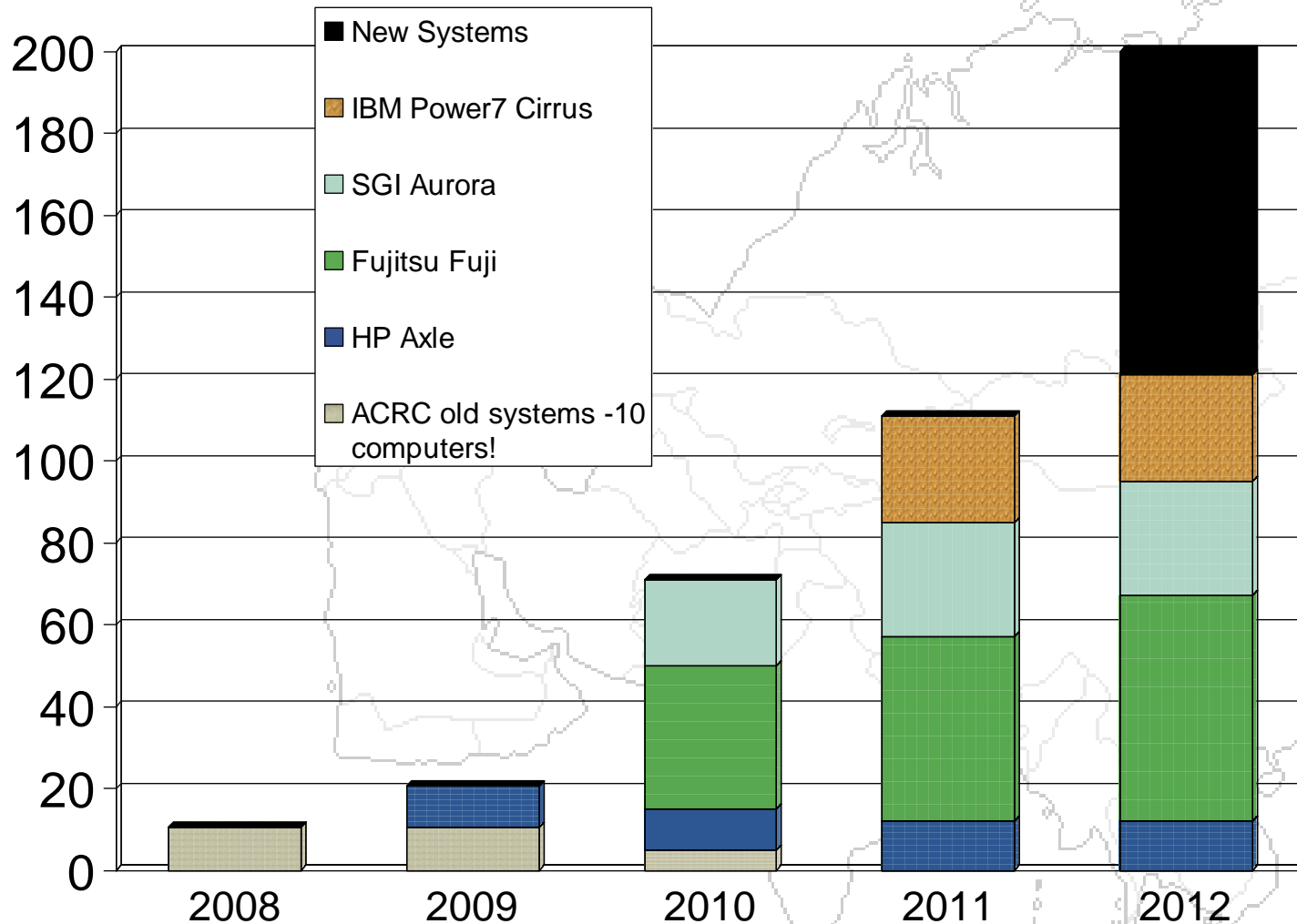*atip*

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Typical SG HPC Users

- A*STAR Research Institutes (IHPC, BII, GIS, etc)
- National University of Singapore
  School of Computing, Faculty of Sci, Faculty of Eng,
  Tropical Marine Sci Inst
- Nanyang Technological University
  College of Eng, School of Physical & Math Sci,
  School of Art, Design and Media, Nanyang Business School
- Ministry of Defense
- SG Univ of Tech & Design (new)
- Mechanobiology Institute, Future Cities Lab
- National Environment Agency (Climate Sci Dept, Env Health Inst)
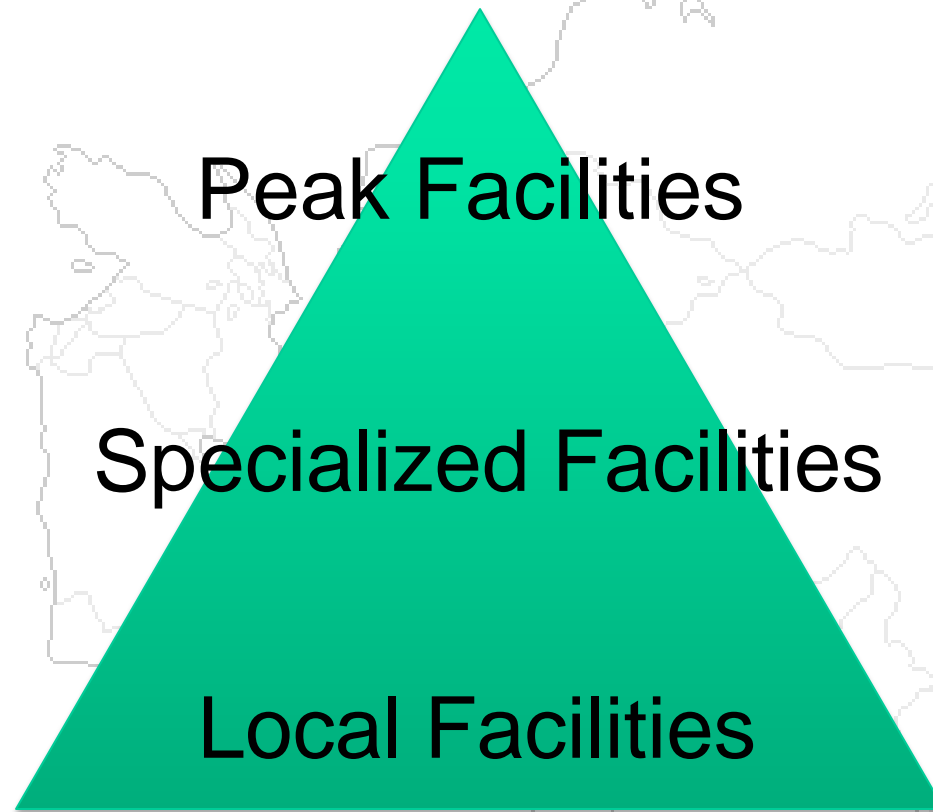
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A*STAR HPC computational power

TFLOP

Legend:
- New Systems (black)
- IBM Power7 Cirrus (orange)
- SGI Aurora (light blue)
- Fujitsu Fuji (green)
- HP Axle (blue)
- ACRC old systems -10 computers! (tan)

Years: 2008, 2009, 2010, 2011, 2012

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Australian HPC Landscape
An HPC User (not creator)

Peak Facilities

Specialized Facilities

Local Facilities

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Peak Facilities
(Petascale in 2012)

National Computational Infrastructure

>   Australian National University

>   Earth Sciences, Climate

Pawsey Supercomputing Centre

>   IVEC

>   Square Kilometer Array Pathfinder project

Victorian Life Sciences Computational Initiative

>   Life Sciences

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AU Specialized Facilities

Multi-modal Australian ScienceS Imaging and Visualization Environment

- Monash University, Australian Synchrotron, CSIRO and VPAC

- Imaging, Visualiszation and the Characterization Community

Specialized Facility for Bioinformatics

- University of Queensland

- Bioinformatics

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Sincere Thanks For Your Interest and Support!

Questions/Comments - Contact Anytime: **Dr. David K. Kahaner**

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