

# Supercomputing in China



## Context and Disclaimer:

These slides were assembled for an after-dinner talk at the banquet of the “Workshop on High Performance Computing with BG/L and QCDOC” held at Brookhaven National Laboratory on October 27 & 28, 2004, delivered by Professor David Keyes of the Department of Applied Physics and Applied Mathematics at Columbia University. Prior to posting on November 1, 2004 at the request of some banquet attendees, they were slightly updated.

This presentation consists of personal observations, contributions from computational colleagues in China who have recently visited the U.S. and from colleagues in the U.S. who have recently visited China, and publicly available data and images. The data has not been assiduously checked though most of it is recently updated from sources believed to be reliable (see penultimate slide for a list of sources).

The presenter’s employer, affiliated laboratories, and research sponsors neither expressly approve nor disapprove of the statements and opinions expressed herein. Hey! This is an after-dinner talk 😊.

Given the rapid pace of change in supercomputing, generally, and in supercomputing in China, particularly, this presentation may become obsolete shortly after posting. In particular, one should check releases of the international Top500 list and the China Top100 list due out later in November 2004.

# Plan of presentation

- Why this topic?
- Social and economic context
- Chinese supercomputing trends
  - Hardware snapshot
  - CS&E snapshot
  - IT R&D snapshot



## Global University

## Columbia Celebrates its Chinese Connections

By Peter Kobel

With participants coming from China, Taiwan, Hong Kong and various parts of the U.S., as well as Columbia University, the symposium "Columbia University: The Chinese Connection," Sept. 10-11, actually originated in the New York borough of Queens. That's because the seed for the event, which examined and celebrated the University's historical ties with China, was planted more than a year ago with Bernadette Li, who received her doctorate at Columbia and now teaches in the Institute of Asian Studies at St. John's University in Queens.

Columbia Trustees Clyde Y.C. Wu and Savio W. Tung approached Li with the idea of doing something in connection with the Columbia 250 celebrations recognizing the role of Columbia in China. Li enthusiastically endorsed the concept.

The seed then grew into a tree that sprouted a total of 12 panels over two days, covering topics ranging from diplomacy to business and economics, from art to science, and from education to law. Organized by Columbia's Weatherhead East Asian Institute under the aegis of C250 and the President's Office, the conference took place at Alfred Lerner Hall and the Columbia Law School.

Columbia's Chinese connections are myriad. As Weatherhead's executive director, Torrey Whitman, said, "The idea was to recognize and celebrate the role Col-

And those connections go back more than a century. The class of 1885 included Columbia's first Chinese graduate. In 1901, a man named Dean Lung gave the University a gift of \$12,000 (accompanied by a letter signed "Dean Lung, a Chinese person"), which helped finance a Chinese studies department. In 1930, the roster of the Chinese student club comprised 30 names.

Columbia has educated countless Chinese leaders, diplomats, scientists, teachers and scholars since then. Just one example, given by Lü Xiaobo, director of the Weatherhead East Asian Institute, during his opening remarks at the symposium: more than half of the heads of teachers schools in China in the thirties and forties were graduates of Teachers College.

Currently, approximately 560 of Columbia's students are from China. Columbia's C.V. Starr East Asian Library holds one of the world's largest East Asian collections outside Asia, with almost 800,000 volumes of East Asian and Western-language books, as well as periodicals and videos (see below for more information on Starr).

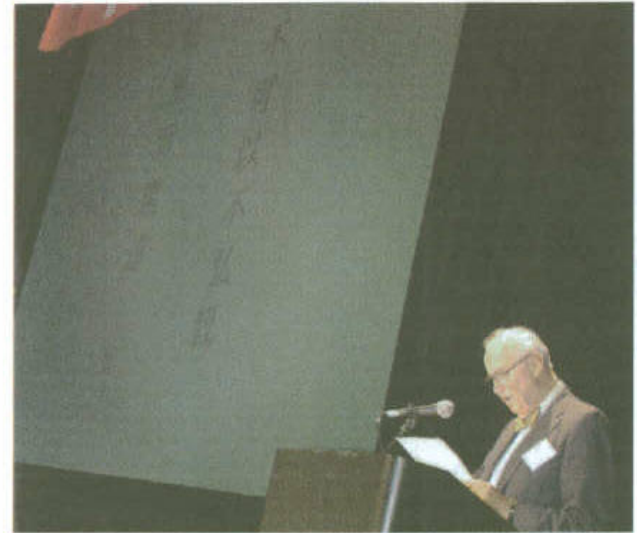
More recently, Columbia President Lee C. Bollinger has made it part of the University's mission to boost Columbia's already large foreign-student population (a large part of which is from East and Southeast Asia) and to strengthen ties in Asia. In the last six months he has visited Beijing's Peking

er at the opening session, had been 87 years old and drove in to work every day from Westchester, except on Tuesdays, when he played tennis.

Whitman read excerpts from Wang's talk in his stead. "There are many ways to cement one's Chinese connections," Whitman read. "Some Columbians have made significant contributions to China as a nation or in a particular region. Others have worked tirelessly for the benefit of the Chinese community locally or all over the world. Yet others have not particularly focused on China or the Chinese, yet have made unforgettable contributions to all Chinese through their outstanding scientific, artistic, literary or humanistic achievements."

Modestly, Wang's speech continued: "In self-reflection, I must confess that I hardly qualify to belong to any one of the above categories, as I am neither sufficiently talented nor focused. Yet through my Columbia connection, I have cultivated and forged various Chinese connections. The major vehicle has been my role as an economist to help China develop. Whatever the outcome might be, I have felt a sense of satisfaction in maintaining my Chinese connection through my Columbia connection."

In his keynote address at the symposium's opener, William Theodore de Bary, John Mitchell Mason Professor of the University and Confucian scholar, brought the conversation back to China's influence on the world and Columbia.



Above: William Theodore de Bary, John Mitchell Mason Professor of the University and Confucian scholar, brought the conversation back to China's influence on the world and Columbia.

# Why this topic?

- China is “the land of graduate students”
  - About 10% of Columbia’s own 7000 students and scholars in residence are Chinese
- China graduates 325,000 engineers/year
  - Five times U.S. annual graduation rate
  - Engineering wages are 10-15% of U.S.
  - Overall factor of 30-50 productivity advantage, modulo tools and training level
- Supercomputing a prime engineering tool
  - Chinese supercomputing advancing rapidly

# Why this topic? (cont.)

- Several participants at today's workshop attended the Nankai Supercomputing Conference in Aug 2004
  - Guests of Yuefan Deng
  - Among DOE delegation: Davenport, Dongarra, Keyes, Simon
- Starring **Nankai Stars, #42 in the world**





*The xSeries Xeon 3.06 GHz, Myrinet*

*Manufactured by IBM*

*at the Nankai University*

*China*

is ranked

*No. 42*

among the world's TOP500 Supercomputers with

3.23 TFlop/s Linpack Performance

The 23rd TOP500 list was published at the ISC2004 Conference in Heidelberg, Germany,  
June 23rd, 2004

Congratulations from The TOP500 Editors

A handwritten signature in black ink, appearing to read "Hans Meuer".

Hans Meuer  
University of Mannheim

A handwritten signature in black ink, appearing to read "Erich Strohmaier".

Erich Strohmaier  
NERSC/Berkeley Lab

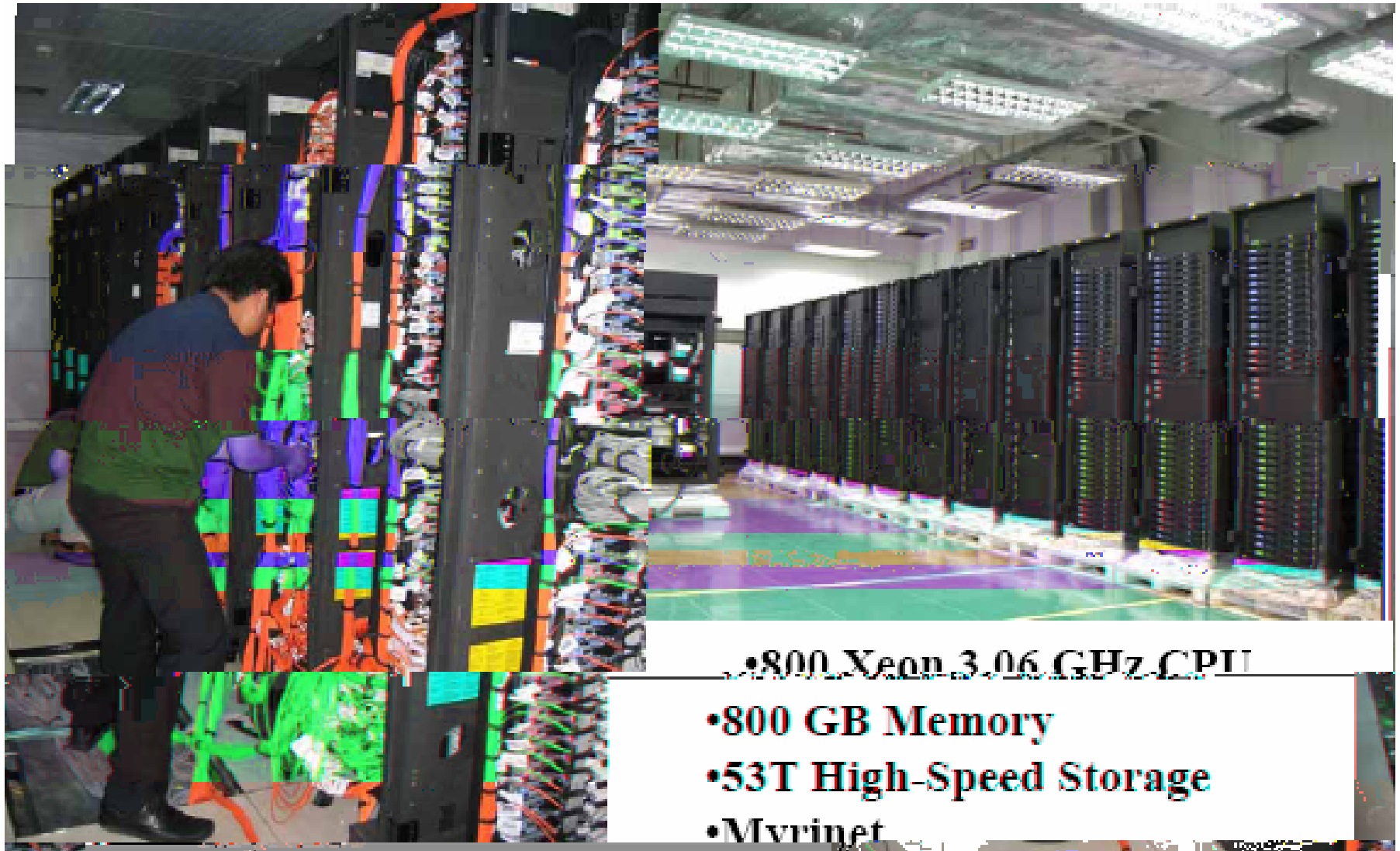
A handwritten signature in black ink, appearing to read "Jack Dongarra".

Jack Dongarra  
University of Tennessee

A handwritten signature in black ink, appearing to read "Horst Simon".

Horst Simon  
NERSC/Berkeley Lab

# Nankai Stars: A Supercomputer by and for middle class



- 800 Xeon 3.06 GHz CPU
- 800 GB Memory
- 53T High-Speed Storage
- Myrinet

Slide c/o Professor Yuefan Deng



# Nankai Supercomputing Conference principals

# Nankai University's lovely urban oasis campus



Brookhaven's Jim Davenport in the Tianjin evening news





The Mayor of China's third largest city announces operating support

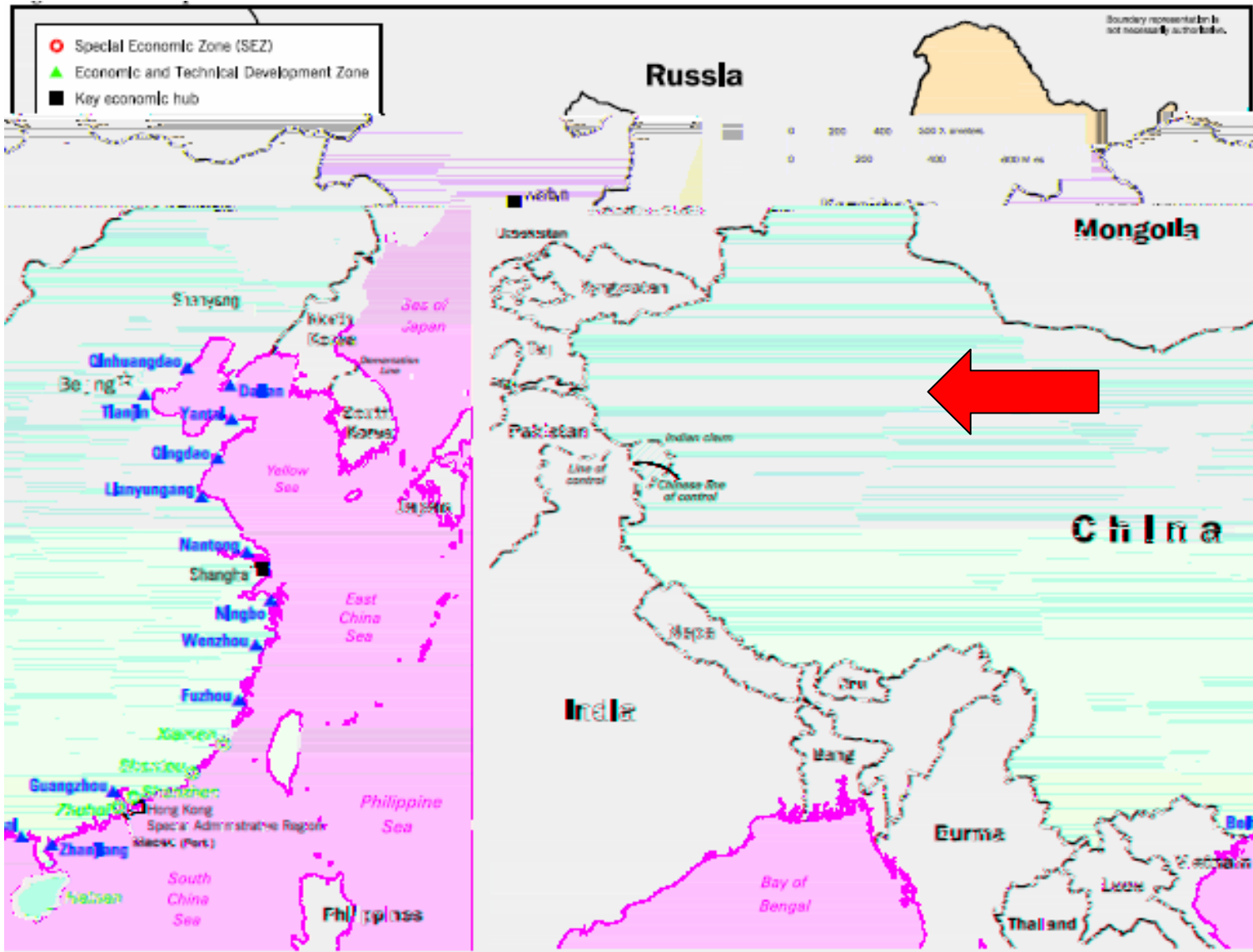


Nankai University's president offers a toast





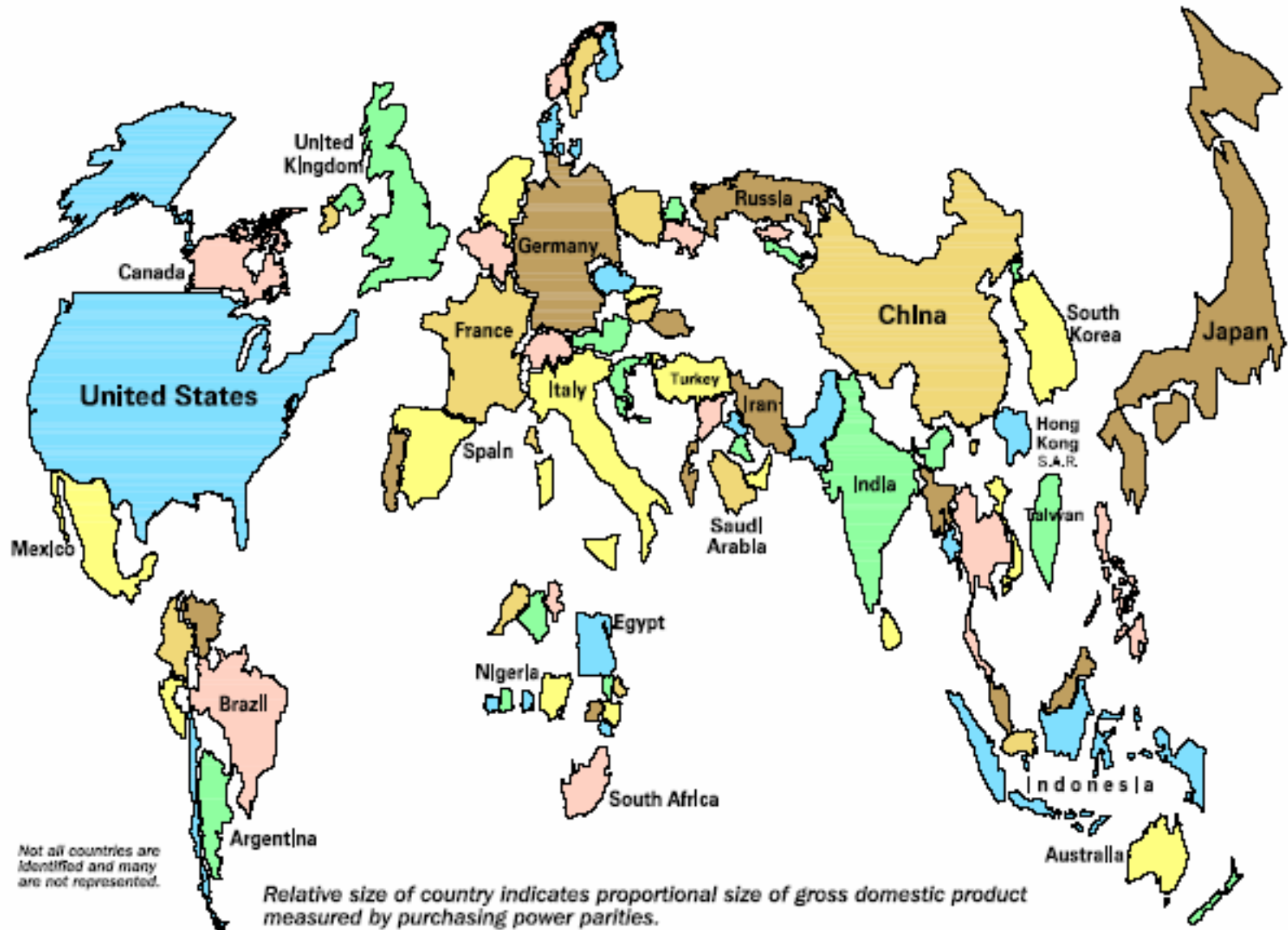
# Tianjin's location



# Social and economic context



# GDP measured in PPP

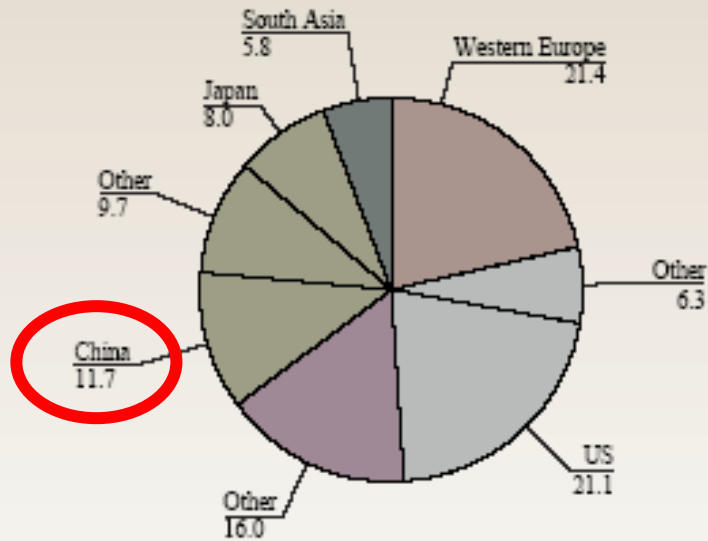


# GDP and population

Percent

GDP

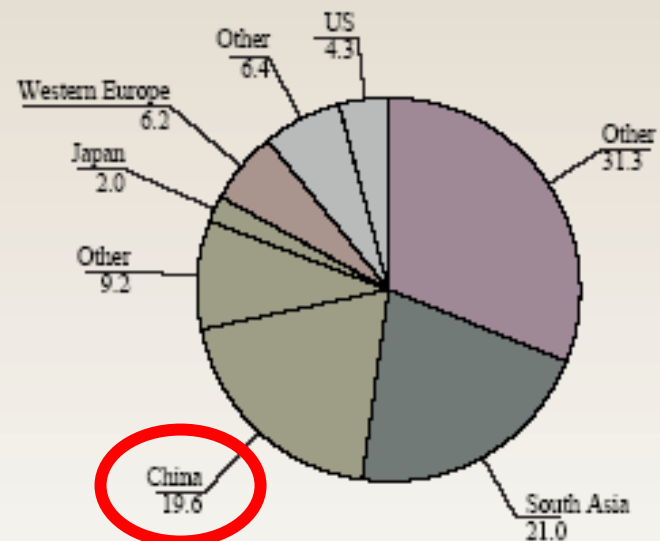
- East Asia/Pacific
- Western Hemisphere



38.7 trillion 1997 US \$

Population

- East Asia/Pacific
- Western Hemisphere



6.2 billion persons

... one of out every nine dollars for one out of every five people...

## GDP Growth: 30 Years of Structural Change

RMB billion, nominal

12,000

10,000

8,000

6,000

4,000

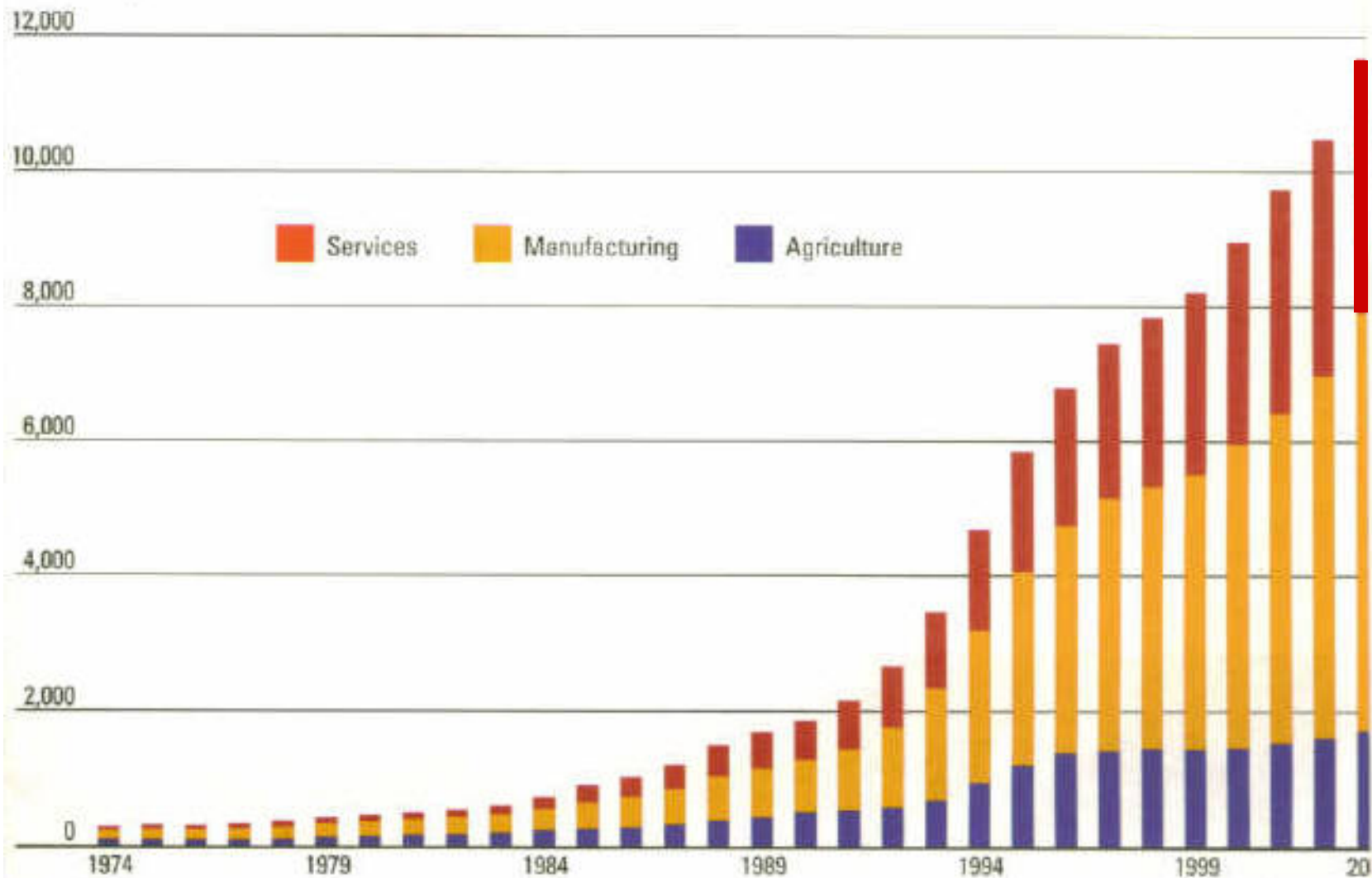
2,000

0

Services Manufacturing Agriculture

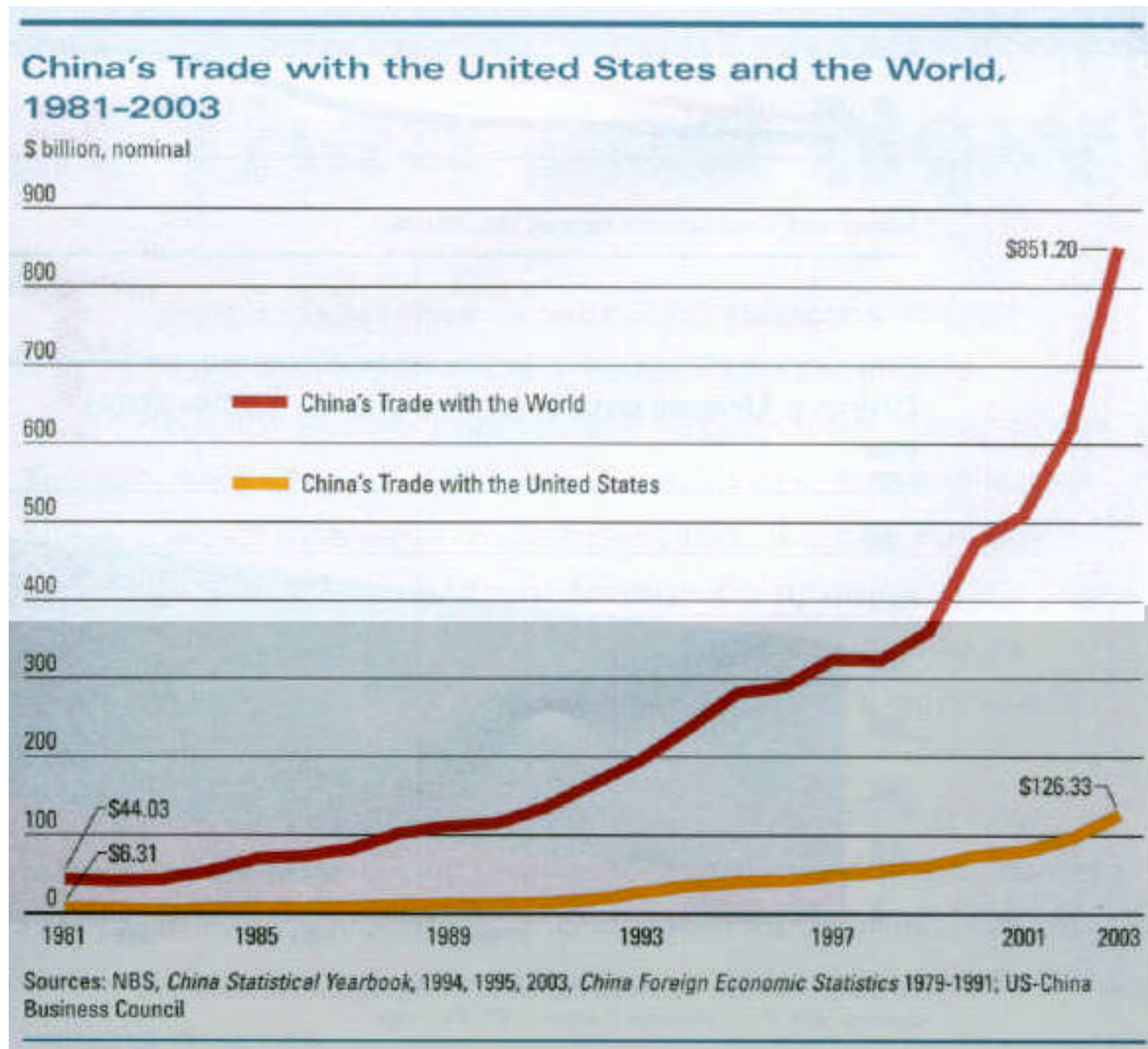
1974 1979 1984 1989 1994 1999 20

Sources: PRC National Bureau of Statistics (NBS). *China Statistical Yearbook*. 2002, 2003





# Trade with US & rest of world

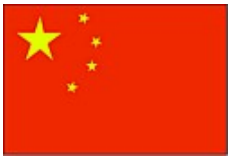




# Almanac data



\$1.6T	GDP	\$11.5T
8.1%	Growth (2004)	4.7%
2.7%	Inflation (2004)	1.4%
\$529B	Exports	\$814B
\$505B	Imports	\$1,395B
\$24B	Surplus	(\$581B)



# Almanac data



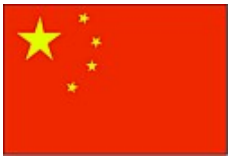
1,304M	Population	294M
43.2Q 10.5%	Energy cons. (BTUs) & world %	98.1Q 23.8%
33.1M	Energy cons. per capita	333.7M
3.3B (14%)	CO <sub>2</sub> prod. (tons)	5.8B (24%)
2.57M	CO <sub>2</sub> prod. per capita	19.7M
7,213	Energy intensity (BTU/\$PPP)	9,348



# Almanac data



1,304M 24.3%,7.3%	Population <15, >65	294M 21%,12.6%
3.71M	Area (sq.mi.)	3.72M
10%	% Arable	19%
\$20B	Defense budg.	\$351B
2.27M	Active troops	1.41M
50 / 22 / 28	Labor force % agr / ind / svc	2 / 24 / 74



# Almanac data



86%	Literacy	97%
70.3/74.3	Life exp. (M/F)	74.4/80.1
13.0	Births/1000 pop.	14.1
25.3	Inf.mort./1000 bi.	6.8
~20M	Vehicles	220M
291	TVs/1000 pop.	844





# Almanac data

Populations of 10 largest cities (in thousands)

Shanghai	8,214	New York	8,086
Beijing	7,362	Los Ang.	3,820
Tianjin	5,855	Chicago	2,869
Shenyang	4,669	Houston	2,010
Wuhan	4,040	Philadel.	1,479
Guangzh.	3,935	Phoenix	1,388
Chongqing	3,127	San Diego	1,267
Chengdu	2,954	San Anton.	1,214
Xi'an	2,872	Dallas	1,208
Nanjing	2,678	Detroit	911

Hong Kong  
6,827

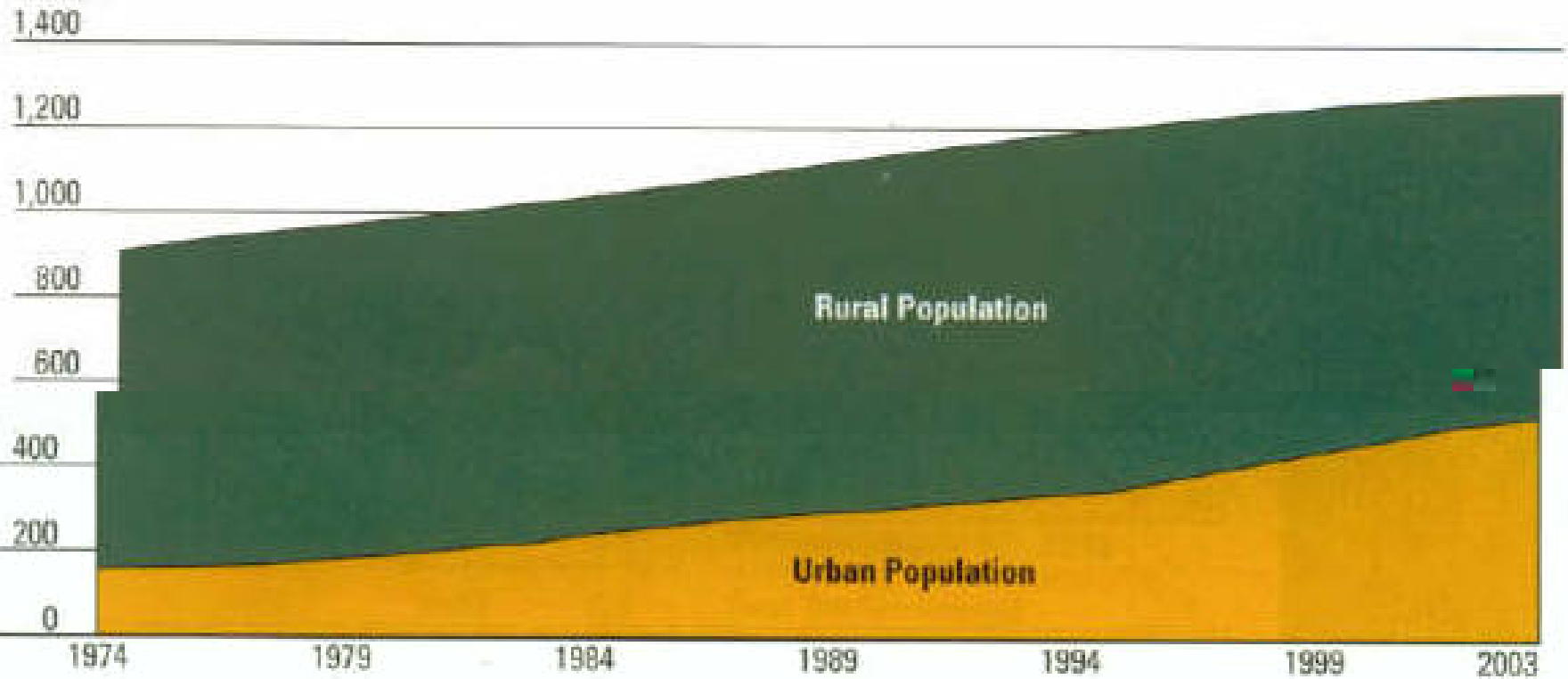
*~100 cities  
of 1M or  
more in  
population*

*9 cities  
of 1M or  
more in  
population*

# Urbanization

## China's Urbanization in Progress, 1974-2003

Million



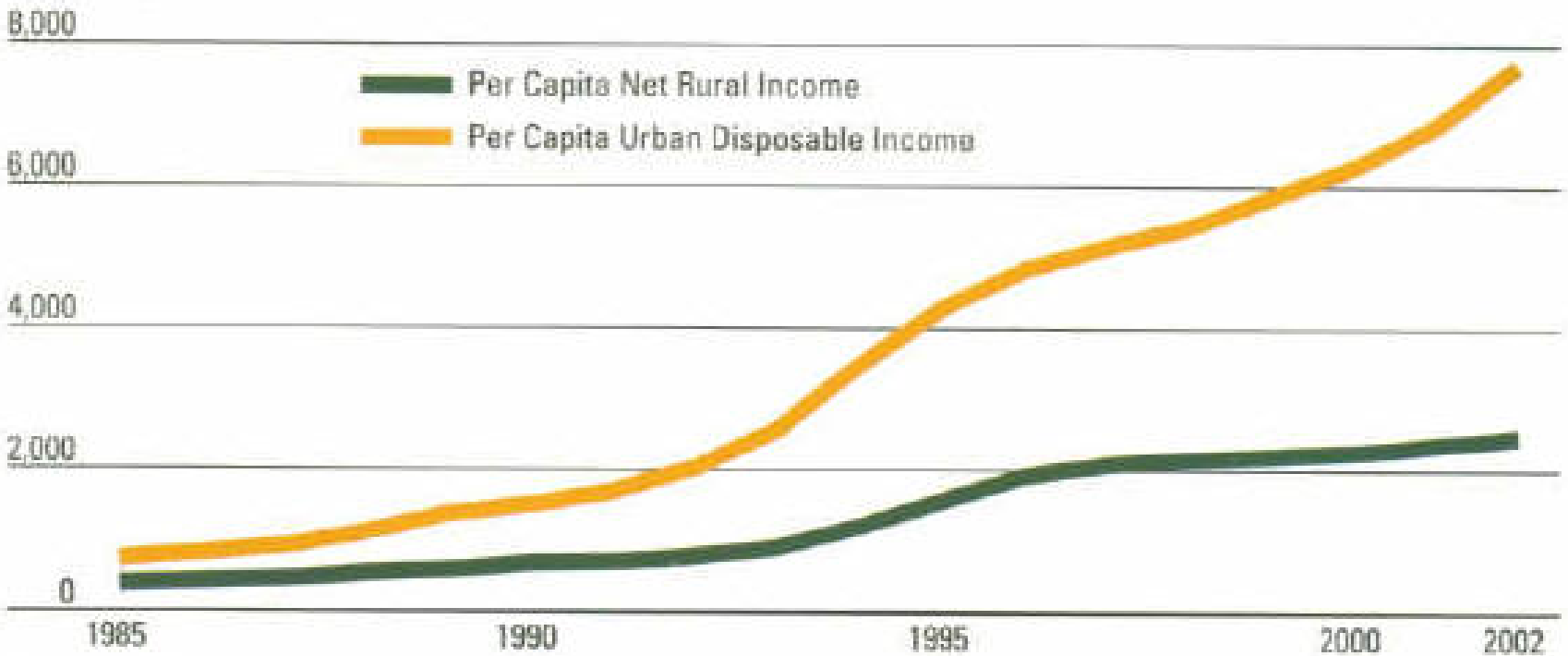
Note: Data in this table exclude the populations of Hong Kong, Macao, and Taiwan.

Sources: NBS, *China Statistical Yearbook*, 1993, 2002, 2003

# Urbanization

## China's Growing Rural/Urban Inequality, 1985-2003

RMB/year, nominal



Sources: NBS, *China Statistical Yearbook*, 1993, 2002, 2003

# Supercomputing hardware





# 14 Chinese Sites on the Top500

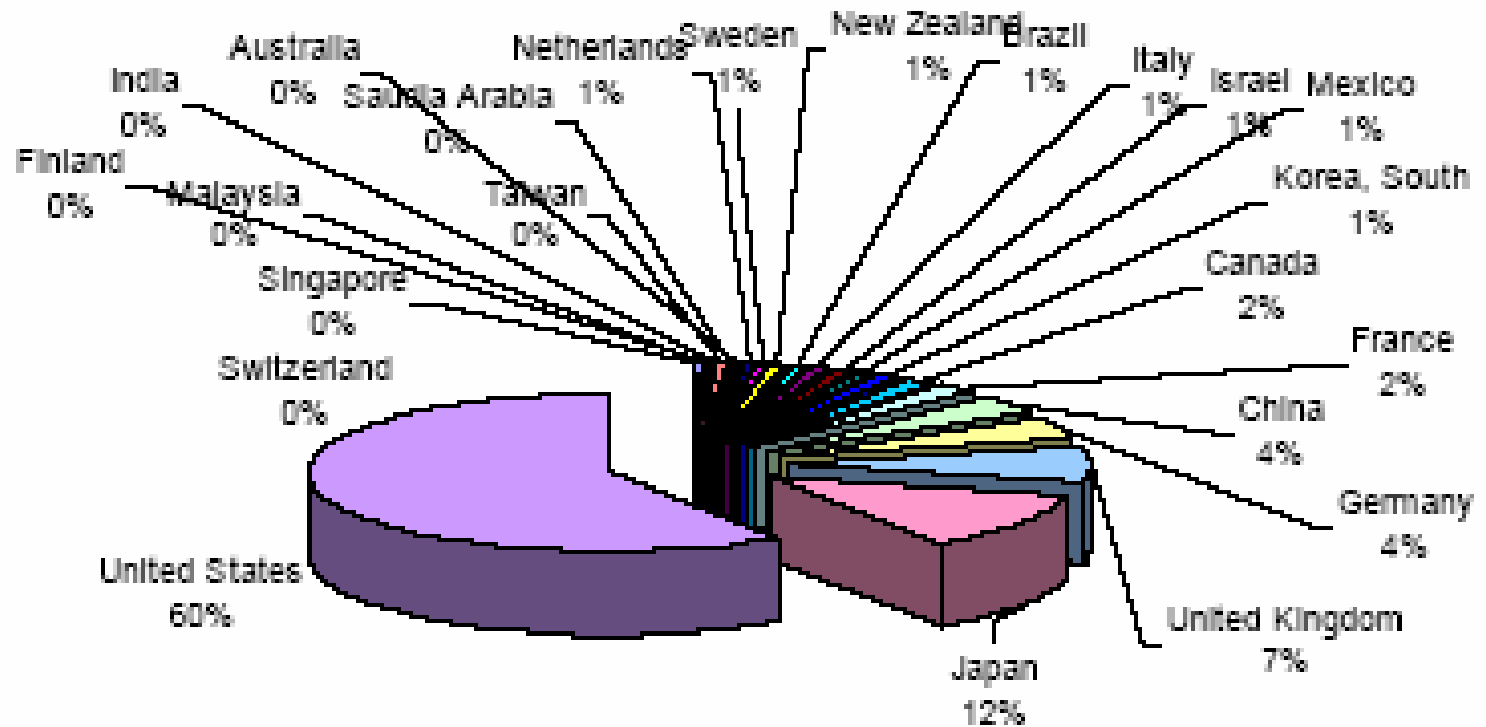
Rank	Site	Manufacturer	Computer	Inst. type	Year	Rmax	Procs
10	Shanghai Supercomputer Center	Dawning	Dawning 4000A, <b>Opteron</b> 2.2 GHz, <b>Myrinet</b>	Research	2004	8061	2560
26	Chinese Academy of Science	lenovo	DeepComp 6800, <b>Itanium2</b> 1.3 GHz, <b>Qsnet</b>	Academic	2003	4193	1024
42	<b>Nankai University</b>	IBM	xSeries <b>Xeon</b> 3.06 GHz, <b>Myrinet</b>	Academic	2003	3231	800
101	Petroleum Company (D)	IBM	BladeCenter <b>Xeon</b> 3.06 GHz, <b>Gig-E</b>	Industry	2004	1922.6	512
126	University of Shanghai	Hewlett-Packard	DL360G3 <b>Xeon</b> 3.06 GHz, <b>Infiniband</b>	Academic	2004	1660	348
139	Geoscience (A)	IBM	BladeCenter <b>Xeon</b> 3.06 GHz, <b>Gig-E</b>	Industry	2004	1547.1	412
169	Academy of Mathematics and System Science	lenovo	DeepComp 1800 - P4 <b>Xeon</b> 2 GHz - <b>Myrinet</b>	Academic	2002	1297	512
176	Public Sector	IBM	xSeries <b>Xeon</b> 2.4 GHz - <b>Gig-E</b>	Government	2003	1256	622
221	XinJiang Oil	IBM	BladeCenter <b>Xeon</b> 2.4 GHz, <b>Gig-E</b>	Industry	2003	1040	448
317	Shenzhen University	Tsinghua University, Shenzhen University	DeepSuper-21C, P4 <b>Xeon</b> 3.06/2.8 GHz, <b>Myrinet</b>	Academic	2003	830.1	256
365	ShanDong High Performance Computing Center	Langchao	TS10000, P4 <b>Xeon</b> 2.8 GHz, <b>Infiniband4x</b>	Academic	2004	749	192
368	LASG/institute of Atmospheric Physics, CAS	lenovo	DeepComp 1800 - P4 <b>Xeon</b> 2.4 GHz - <b>Myrinet</b>	Academic	2002	735.8	256
400	Digital China Ltd.	Hewlett-Packard	SuperDome 875 MHz/HyperPlex	Industry	2004	713	416
492	Huapu Information Technology	Hewlett-Packard	SuperDome 875 MHz/HyperPlex	Industry	2004	638	320

Total performance growing by a factor of 3 every 6 months for the past 18 months

Top 500 aggregations, c/o Jack Do



## Country Percent by Total Performance

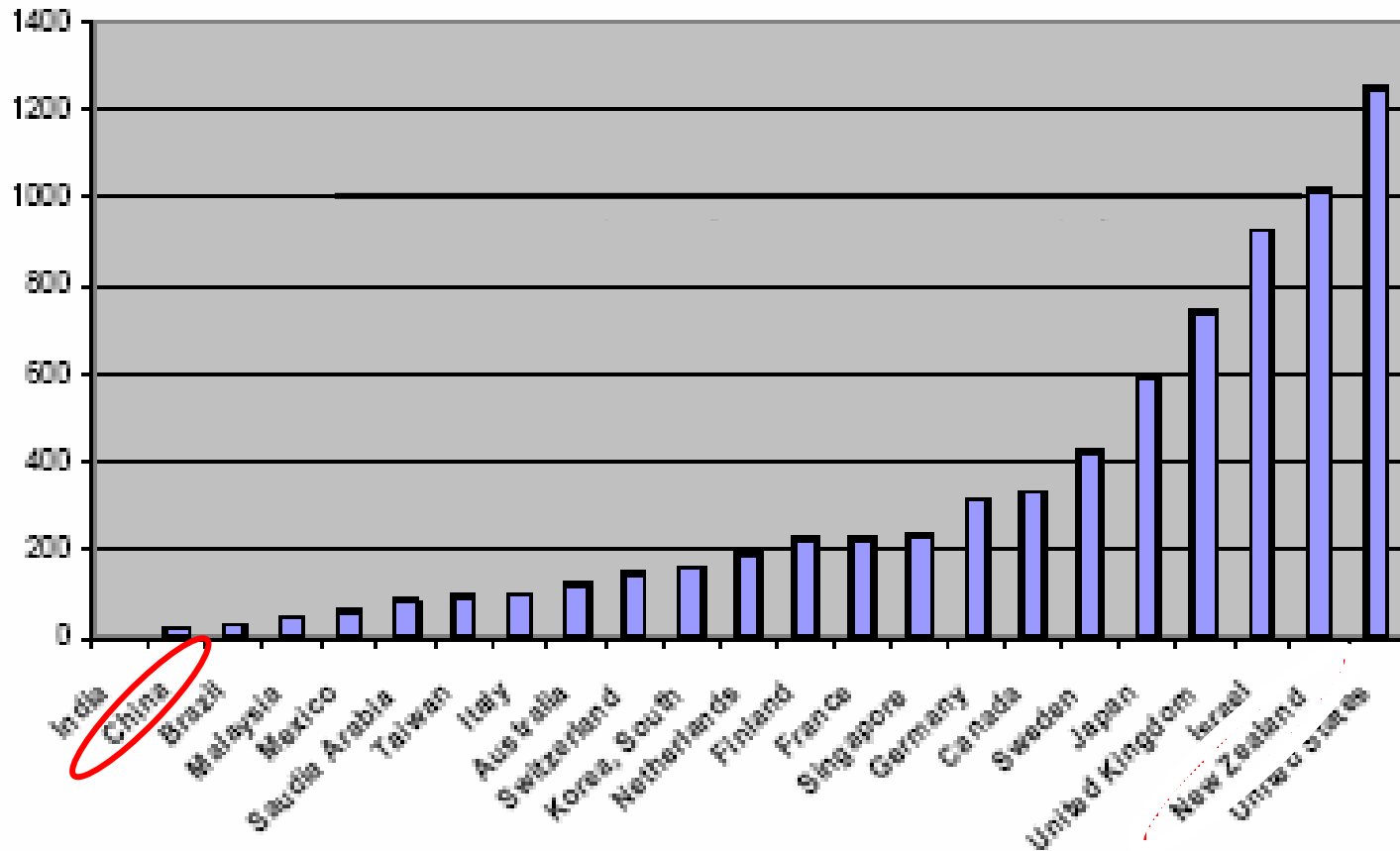




Per capita Top 500 aggregations, c/o Jack Dongarra, June 2004



# KFlop/s per Capita (Flops/Pop)



- Est. 1988 as “Legend”, renamed Lenovo in 2004
- China’s largest IT enterprise
- ~\$4B/year
- ~10,000 employees
- Vision of group of 11 researchers at Chinese Academy of Sciences in 1984
- Primarily markets desktops (dominates domestic market with 27% of sales)
- Watch for sponsorship of  Olympics! 
- Currently markets “DeepComp” supercomputer line

Unveiling of China's first Teraflop/s computer, Legend factory, July 2002,  
to Peking University visitors W. Gropp & D. Keyes



512 Intel  
2 GHz Xeon  
processors  
Myrinet 2000  
Linux

## Poking at the Legend-ary backplane





## Visionaries Jiachang Sun, Chie-Jie Wu, and Linbo Zhang



# Deep Comp 6800



# 6800 Specs

- **Itanium2 Processor**
- **1060 nodes**
  - 1.3 Ghz
  - 3 MB
- **Network**
  - 256 full-bisection QsNet
  - Message-Passing Bandwidth 320 MB/s Delay: 6us
  - Shared-Memory Bandwidth 321 MB/s Delay: 4us
- **Peak performance 5.3 Tflop/s**
  - Total Memory 2.6 TB



## New Dawning of Chinese supercomputing



DAWNING TC4000L SUPER COMPUTER  
copyright by dawning information industry co.ltd  
2003

# Dawning 4000A specs

- Opteron 64-bit
- 640 nodes, each:
  - 4 procs
  - 2.2 GHz
  - 8 GB
- Myrinet2000 and gigabit ethernet
- Peak performance 11.264 Tflop/s

# China Top 100 List background

- Maintained by the Specialty Association of Mathematical & Scientific Software (SAMSS).
- Joint work of Sun Jiachang, Yuan Guoxing, Zhang Linbo, and Zhang Yunquan  
<http://www.samss.org.cn>
- First released as “China Top50” in Nov. 2002
- Release date: beginning of November of each year
- Graduated from “Top50” to “Top100” in 2003
- Reporting on *publicly announced* computers on the *PRC Mainland* only (Taiwan, Hong Kong have one machine ea. on the worldwide “Top 500”)

# China HPC Perf. Analysis

## 2003 vs. 2002 (& peek at 2004)

	2002 (TOP50)	2003(TOP100)	2003/2002	2004
First place	1.046 Tf	4.148 Tf	3.97	8.06 Tf
Tenth place	0.1 Tf	0.38 Tf	3.8	0.84 Tf
Fiftieth place	13.17 Gf	113.8 Gf	8.64	(NA)
# >1Tflops Rmax	1	2	2	9
Total Perf (Top50)	4.6 Tf	16.61 Tf	3.61	
# >1Tflops Rpeak	1	10	10	
# Cluster	7	26	3.7	
Average Efficiency	59.3%	57.9%	0.98	

# 2003 China Top 100 by manufacturer

	Manufacturer	Count	Rmax [GF/s]	Rpeak [GF/s]	Procs
Domestic	Lenovo	9	7194.04	11224.0	2360
	SunWay	7	1660.73	4187.86	1504
	Self-made	4	295.96	597.20	408
	Tsinghua	2	874.9	1600.16	400
	Langchao	2	727.4	1238.4	228
	Huayun/Origin	2	155.5	265.6	50
	Dawning	1	39.00	111.70	160
Domestic Total		27	10943.07	19224.92	5110
Imported	HP	57	6594.08	10032.3	3196
	SGI	8	504.46	614.4	576
	IBM	7	1585.68	4039.4	944
	SUN	1	52.7	64.00	80
Imported Total		73	8732.92	14750.1	4796
Total		100	19724.49	33975.02	9906

c/o Jiachang Sun



# 2003 China Top100 by sector

	Count	Rmax [GF/s]	Rpeak [GF/s]	Processors
Scientific Computing	29	10248.68	15020.76	4912
Financial and Insurance	21	2383.98	3671.30	1168
Telecomm	16	2097.89	3363.10	1012
Tax	8	1208.70	1904.00	544
Energy	7	2250.54	5810.48	1232
Industry	7	759.52	1139.40	400
Bioinformatics	3	1112.30	1724.88	356
Transportation	3	223.18	365.90	160
Meteorology	2	155.50	265.60	50
Postal	2	142.2	224.0	64
Other R&D	1	196.90	307.20	64
Public Sector	1	71.10	112.00	32
Total	100	19724.49	33975.02	9906

c/o Jiachang Sun

# 2003 China Top100 by province

	Count	Rmax [GF/s]	Rpeak [GF/s]	Processors
Beijing	37	12181.11	19058.86	5304
Shanghai	12	1322.80	2355.40	1120
Guangdong	9	1571.14	2700.16	608
Jiangshu	5	680.78	1059.20	352
Anhui	5	650.54	822.40	352
Shandong	4	1297.50	2698.00	608
HeiLongJiang	3	623.04	1726.80	368
HeNan	3	364.97	565.00	184
HeBei	2	251.10	419.20	96
SiCuan	2	216.00	416.00	104
ShanXi	2	154.10	230.40	66
HuBei	2	138.88	216.20	60
TianJin	2	123.80	176.00	112
JiLin	2	114.55	152.30	104

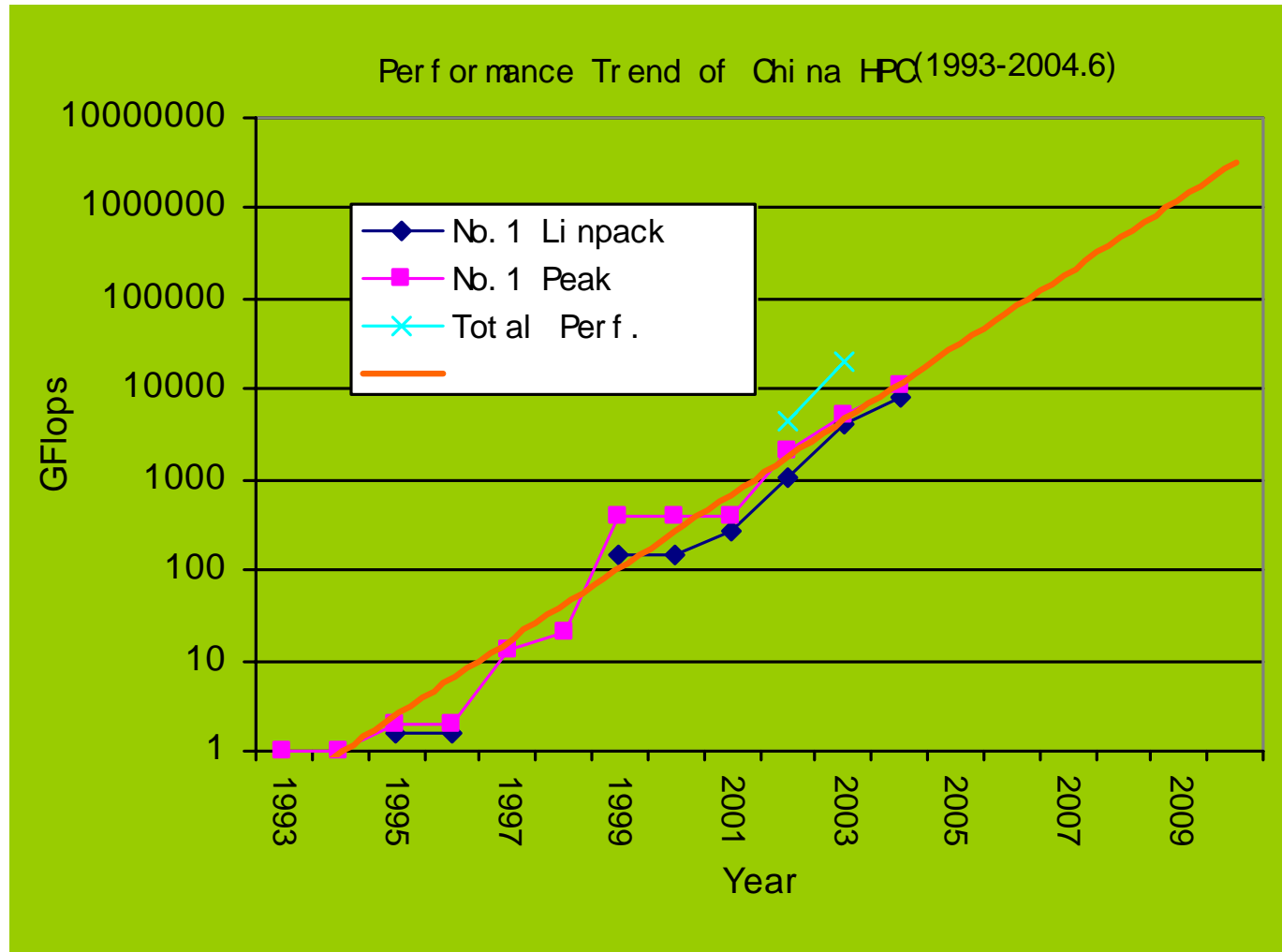
c/o Jiachang Sun

# 2003 China Top100 by province

	Count	Rmax [GF/s]	Rpeak [GF/s]	Processors
LiaoNing	1	142.20	224.00	64
FuJian	1	142.20	224.00	64
GanSu	1	115.20	179.20	32
HuNan	1	113.80	144.00	48
Inner-Mongolia	1	113.80	144.00	48
JiangXi	1	80.60	114.80	52
GuangXi	1	71.10	112.00	32
ZheJiang	1	64.20	76.80	64
SanXi	1	62.00	88.30	40
XinJiang	1	52.56	72.00	24
<b>Total</b>	<b>100</b>	<b>19724.49</b>	<b>33975.02</b>	<b>9906</b>

c/o Jiachang Sun

# Trend of China HPC Performance (1993-2004 to date)



c/o Jiachang Sun

# Sun's concluding remarks

- “A great success on HPC in China has been made”
- “There is still a big distance between China and world high level in HPC system”
- “Software is our main weak point to be strengthened, but it hasn't got enough attention from our decision makers”

Never heard this before 😊

# Computational Science

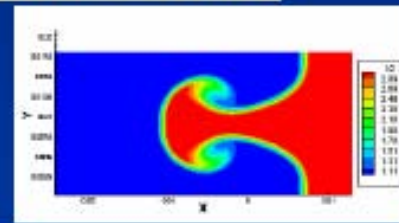
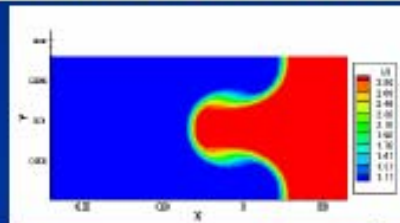
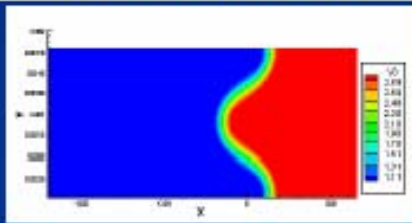






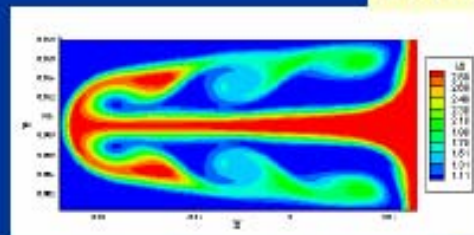
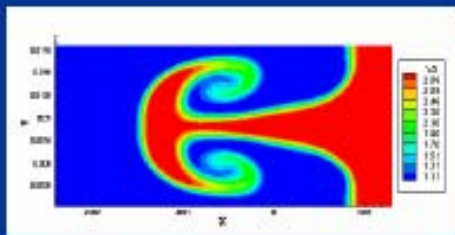
# Nonlinear evolution of the RTI without ablation for single-mode and multi-mode perturbations

Perturbation evolution is divided five stages below.



RT Linear growth RT mode-coupling

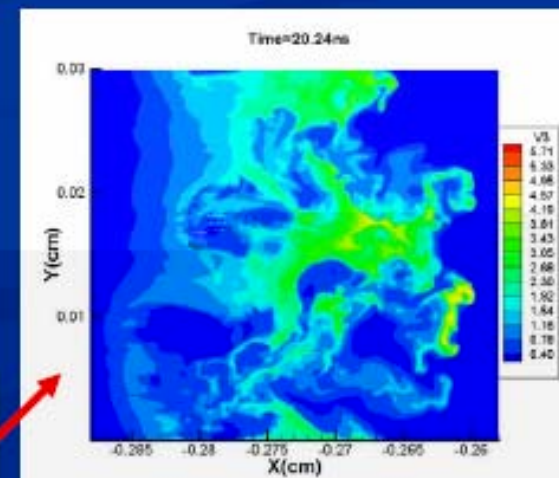
KHI taking place, formation of mushroom and eddy



mushroom development

mushroom expansion and mix

turbulence from multi-mode perturbation

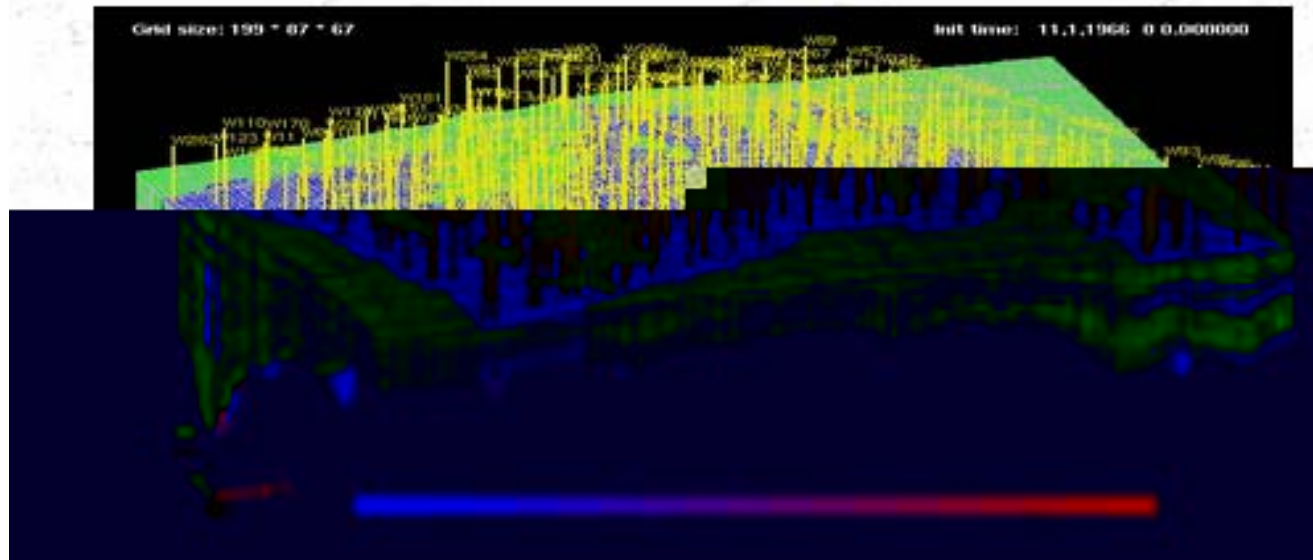


## Oil reservoir simulations, Jiachang Sun

### A practical problem

Black oil Model(Data from DaQing Oil-Field)

- Grids :  $199 \times 87 \times 67 = 1,159,971$
- Wells : 291
- Rock type : 6
- History matching : 31.5 years



Historical capability improvements, oil reservoir simulations, Jiachang Sun

## Simulation Record of PRIS

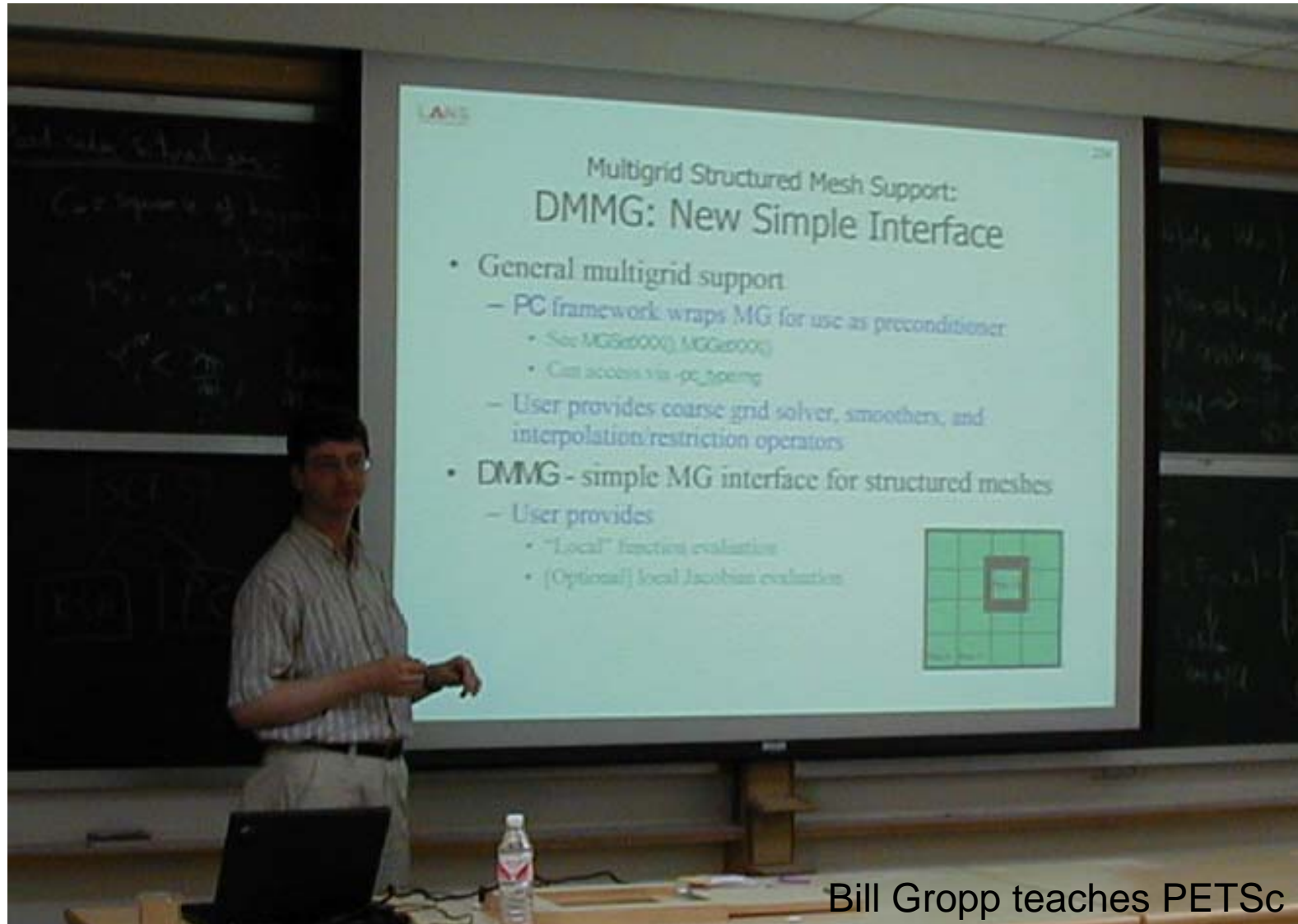
PRIS: Parallel Reservoir Integrated Software, developed by Institute of Software, Chinese Academy of Sciences

- Computing platform of PRIS  
The up to date version PRIS has running on many kinds of parallel platforms in China, such as SGI Power Challenge, Dawning 2000/3000, Sunway-1, Deep Comp 1800/6800, and so on.
- Simulation Record (1998-2002)

Year	Machine	Model	Proc.	Memory	Time
1998	SGI Power Challenge	MIPS,195MHz	1	4G	> 2 M
1999	RDCPS Cluster	PIII500	16	256MB	63.9 H
2000	Dawning 2000	PowerPC 604	64	512MB	27.1 H
2001	Sunway-1	Alpha 21164	64	128MB	24.2 H
2001	Dawning 3000	Power 3 375MHz	16	2G	11.9 H
2002	Deep Comp. 1800	Intel Xeon 2GHz	128	1G	0.94 H
2003	Deep Comp. 6800	Itanium2 1.3GHz	256	2G	0.68 H



# Peking Univ. workshop, Jul 2002



# Some software said to be in use in Chinese universities and institutes

- mpich
- FFTW
- ScaLAPACK
- PETSc
- Hypre
- Overture
- SAMRAI
- GDPK
- TAO

# Peking University CS&E

- Professor Pingwen Zhang, Director
- Faculty recruited from JHU, PSU, Princeton, UCLA
- Excellent facilities
- Top one-percentile student recruitment
- State-of-the-art applications and software
- Posters lining the hallways look like any U.S. university's or national lab's



# CompSci core faculty (& visitors!)



# NUAA workshop, Dec 2002

Nanjing University of Aeronautics and Astronautics students welcome D. Keyes to a presentation of their work. Dean Ning Zhao of NUAA spent 2001-2002 at SUNY-SB.

# Faculty residence, NUAA

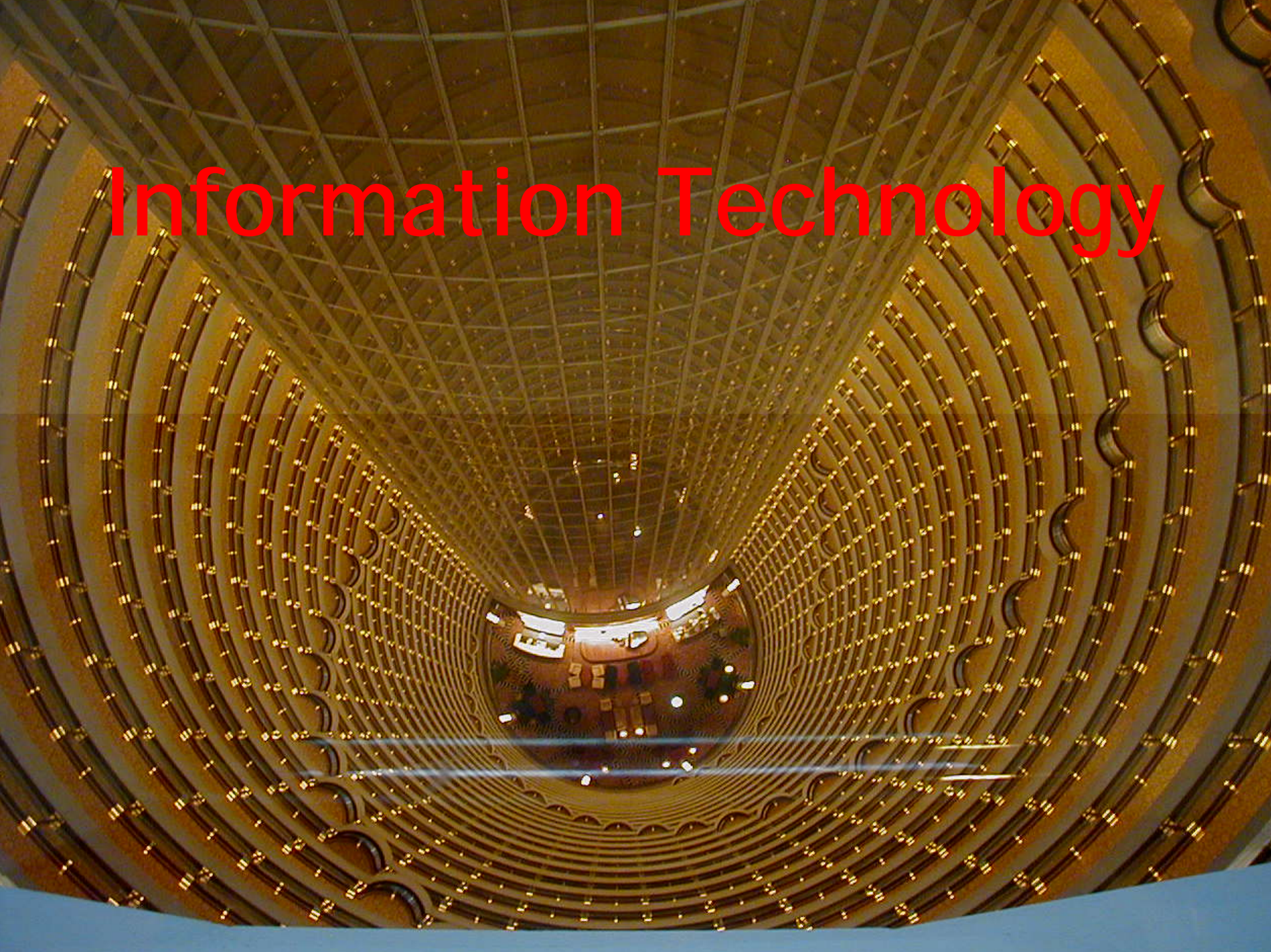


# Major Chinese initiatives

- “Project 863” , multiyear (resource estimates)
  - China Grid, \$25M



# Information Technology



# Galactic Computing, Ltd.

- Founded in 1999
- Steve Chen, architect of Cray XMP & YMP, is CEO
- Focused on social/commercial IT infrastructure
- Ambitious plans for information economy and information-rich society, *relatively unencumbered by lawyers* 😊
- Subject of article in *NYTimes* by John Markoff



# Have Supercomputer, Will Travel

Steve Chen, a pioneer in superfast computing, said he had difficulty finding venture-capital funding after the Internet bubble burst.



## Have Supercomputer, Will Travel: Pioneering Designer Leaves U.S.

Continued From First Business Page

pany that supported an earlier Chen venture and with further backing from a group of Chinese universities. His move reflects the fact that the market for high-performance computing is growing more rapidly in China than elsewhere in the world.

The Chinese are not yet a supercomputing, but computing

ber 1987, Mr. Chen established his own supercomputing company, Supercomputing Systems, with backing from International Business Machines.

That effort led to a partially funded prototype, but the company eventually shut down in 1999.

# The New York Times

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By JOHN MARKOFF

### A technology pioneer leaves the U.S. for opportunities in China.

SAN FRANCISCO, Oct. 25 — Add Steve Chen to the growing list of America's high-technology exports.

Mr. Chen, a Taiwanese-born American citizen who was considered one of the nation's most brilliant supercomputer designers while working in this country for the technology pioneer Seymour Cray in the 1980's, has moved to China — where he

Jose, Calif., where his wife, Kate, and their four children live.

pany looked more promising to him than in the United States, where he was able to secure financing from American venture capitalists for his latest idea. Chen concluded that the fallout from collapse of the Internet bubble had soured the investment climate.

"I saw the crazy stuff going on," he recently in a telephone interview from Shenzhen, near Hong Kong. "A lot of people got hurt."

While Mr. Chen is not a native of

...demonstrated a prototype of Chen's newest supercomputer at a biomedical research institute in Beijing. The machine, he said, is capable of one trillion calculations a second, a performance level that would place it among the top half of the world's 500 fastest computers.

Such computing now occupies a central role throughout the global economy, providing stark proof that decades-long American attempts to control the flow of advanced information-processing technologies are largely moot. It is only a matter of time, experts say, before companies in places like China, India and Russia essentially match the capabilities of the American and Japanese leaders.

"When they really get noticed," said Horst D. Simon, director of the computation center at the Lawrence Berkeley National Laboratory in California, "will be when a country like Malaysia or Australia decides to buy a supercomputer from a Chinese

...Clinton administration, Washington attempted to control the flow of high-performance computers to China because of fears they could be used to design nuclear weapons. That policy, with modifications, has continued. Indeed, just this month, State Department officials renewed calls for maintaining the arms sales embargo against China, which extends to restrictions on the fastest computers.

But with the new type of supercomputer — which blends thousands of freely avail-

**A human technology transfer may help China advance its goals of scientific leadership.**

able off-the-shelf microprocessors connect-

# Galactic Computing vision

“facilitate our global society to achieve the highest productivity in human creativities and natural resources”

“make distributed collaborators as much like same-place work as possible”

- e-health care
- Digital classroom
- RFID cargo-tracking, dynamic supply chain
- e-entertainment on demand
- Digital borders for national security

# IT trends

- 140,000 of the 400,000 Chinese educated abroad in the past two decades have repatriated
- Shenzhen alone has 300 IT companies founded by repatriates
- China is now world's largest supplier of TVs, DVD players, and cellphones
- Foreign investors have made or committed to \$15B in investments in 19 semiconductor plants

# IT trends, cont.

- 400 R&D centers (mainly “D”) started by multinationals in China
- China is third in the world in national investment in R&D, broadly interpreted
  - Currently \$60B per year
  - Cf. \$282B in US (#1), \$104B in Japan (#2)
- Moving up in biotech and high-tech computer engineering
- No longer the place to go for cheap wages; *now the place to go for ready supply of high skills*

# Concluding remarks

- Strongly western-oriented cities on eastern seaboard make visits pleasant and easy
- Strong interest in scientific collaborations with US and Europe
- Highly trained students
- All trends point toward eventual parity in hardware and computational science know-how

# Urban China's "westernness"

- 287M NBA fans, versus 107M in US
- Starbucks, KFC, McDonalds, Pizza Hut as common as noodle shops
- Brittny on the billboards
- Simon & Garfunkel in the malls
- "Cats" in the theaters
- Dali retrospective in the museums
- Versace, Christian Dior, Benetton, etc. in the storefronts
- Seasonal décor (e.g., Santa Claus) in the hotel lobbies



Hi-speed wireless connection to



play-by-play, Aug 2004, Beijing hotel



# Sources

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- *www.nytimes.com* archives
- Presentations at Nankai workshop
- Personal communications
- Personal seminar and conference visits to Beijing, Hong Kong, Nanjing, Shanghai, Tianjin, Wuxi, and Xi'an (1993-2004)

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