A Global Perspective on Parallel Processing Research for Scientific Computing in Japan

- Historical overview of Japan and US HPC’s
- What is the difference between Japan and US trends?
- Current HPC in Japan

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1970’s \textcolor{red}{(red for vector machines)}

- **USA Vendors:** \textcolor{red}{ASC(72), STAR-100(73), ILLIAC-IV(73), Cray-1(76), HEP (79)}
  - Y. Muraoka, K. Miura and others learned at ILLIAC IV.
- **UK:** ICL DAP (79)
- **Japan. Vendors:** FACOM 230/75 APU(77), HITAC M180 IAP(78)
- **Kyoto U (Electric Eng.):** QA-1(74), QA-2 \textcolor{cyan}{(VLIW)}
  - Signal processing, Image processing
- **Kyoto U (Nuclear Eng.):** PACS-9(78) \textcolor{green}{(U. Tsukuba)}
  - Reactor simulation
1980’s (Vectors)

• USA Vendors:
  – Cyber-205 (81), XMP-4 (84), Cray-2 (85), IBM 3090 VF (85), ETA-10 (87), YMP (88)
  – Convex C1 (85), SCS-40 (86), Convex C2 (88), Supertek S1 (89)

• Japan. Vendors:
  – Hitac S810/20 (83), S820 (87)
  – FACOM VP200 (83), VP2600 (89)
  – NEC SX-2 (85), SX-3 (90)
1980’s (US Parallel)

- Parallel Ventures in US and E:
  BBN Butterfly (81), Cosmic Cube (83),
  Elxsi 6400 (83), Pyramid 90x (83),
  Balance 8000 (84), nCUBE/1 (85),
  Alliant FX/8 (85), Encore Multimax (86),
  FPS T-series (86), Meiko CS-1 (86),
  CM-1 (86), CM-2 (87),
  Multiflow Trace/200 (87)
1980’s (Japan Parallel)

• Japan. Activities (mainly for research):
  – U. Tsukuba: Pax-32 (80), Pax-128 (83), Pax-32J (84), qcdpax (89) for qcd
  – Fifth Generation (ICOT) of MITI 82-92 PIM machines for inference
  – Supercomputer Project of MITI 81-89 PHI, Sigma-1 (dataflow), CAP, VPP (GaAs)
  – Osaka U.: EVLIS (82) for LISP
  – Keio U.: SM² (83) for sparse matrix
  – U. Tokyo: Grape-1 (89)
  – No commercial parallel machines
1990’s (USA)

• USA Vectors: C90 (91), Cray-3 (93), T90 (95), SV1 (98)

• USA Parallel (now mainstream):
  – CM-5 (92), KSR-2 (93), SPP (94)
  – SP1 (93), SP2 (94), ASCI Blue Pacific (97), Power 3 SP (99)
  – T3D (93), T3E (96)
  – ASCI Red (97)
  – Origin 2000 (96), ASCI Blue Mountain (98)
1990’s (Japan)

- Japan. Vectors: **S3800** (93), **NWT** (93), **VPP500** (93), **SX-4** (95), **VPP300** (95), **VPP5000** (99)
- Japan. Parallel:
  - cp-pacs (96), SR2201 (96), SR8000(98)
  - AP1000 (94), AP3000 (97)
  - Cenju-2 (93), Cenju-3 (94), Cenju-4(97)
  - Except SR’s, they are sold as a testbed.
- RWCP project (MITI, 92-02): Cluster connected by Myrinet. SCore middleware.
Current High-End Machines

• T2K machines:
  − U. of Tokyo: Hitachi, 12288 cores, 82.98 Rmax, 113.05 peak, 638.60 KW (16th)
  − U. of Tsukuba: Appro/Cray, 10000 cores, 76.46 Rmax, 92.00 peak, 671.80 KW (20th)
  − Kyoto U.: Fujitsu, 6656 cores, 50.51 Rmax, 61.24 peak (34th)

• Tsubame
  − Tokyo Inst. Tech.: NEC/Sun, 12344 cores, 67.70 Rmax, 109.73 peak (24th)
Current High-End Machines

• Earth simulator:
  – NEC, 5120 cores, 35.86 Rmax, 40.96 peak
  – Next Generation: 130 TF peak, SX-9 (Mar. 2009)

• NIFS
  – Current: SX-7
  – Next Generation: Hitachi SR16000, 77 TF peak (Mar. 2009)
Next-Generation Supercomputer

• Japan has to provide supercomputer infrastructure to promote scientific and engineering research.

• Japan started a seven year project (so called KEISOKU京速 computer project) to develop supercomputer and its applications.

• Started in April, 2006
Roadmap of Supercomputers

課題

超高速、超高性能ネットワーク技術、超高速専用計算機（アクセラレータ）の開発

複数の現象の解析や、シミュレーションを統合するためのアプリケーション・ソフトウェア、及びシステム・ソフトウェアの開発

多種多様な利用者の誰もが使いやすいユーザフレンドリーなシステムの実現

【2007年問題】スーパコン開発のベテラン技術者が大量引退し、技術伝承が困難に

取り組み状況と今後の挑戦

「ハードウェア要素技術の研究開発」（2005年度〜）を文科省が開始。＜日本の強みをより強く＞

「革新的シミュレーションの研究開発」（2005年度〜）を文科省が開始。＜日本の課題を克服＞

プロジェクトを通じ、中堅・若手技術者の育成を強化し、円滑な技術伝承を進めることが不可欠

実効性能（FLOPS）

100ベタ
1ペタ
10テラ
100ギガ

1990年
2000年
2010年
2015年
2020年

Source: Mext web
Next-Generation Supercomputer

• Architecture:
  – Fujitsu: scalar part
  – NEC-Hitachi: vector part
• Target: 10 PF by LINPACK
• Power: <30 MW
• No details have been disclosed yet.
  – MPP of many/multicores, perhaps
In Port Island in Kobe city
Observations (1/4)

• Until late 1990’s, Japanese vendors focused on vector machines.
• Users exploited the power of vectorization.
• Vendors thought parallel machines were for specialized purposes (eg. image processing). Most users dared not try to harness parallel machines in the 80’s.
• Some computer scientists were interested in building parallel machines, but they were not used for practical scientific computing.
Observations (2/4)

• Practical parallel processing for scientific computing was started by application users: qcd-pax, NWT, cp-pacs, GRAPE’s, ES.

• Softwares
  – Very good vectorizing compilers.
  – Users were spoiled by them.
  – Users found difficulties in using message passing.
  – HPF efforts for the Earth Simulator.
  – OpenMP, OpenMPD
  – SCore from RWCP
Observations (3/4)

• Japan is at least ten years late in parallel processing for scientific computing as compared with US.

• Education in parallel processing is a urgent issue for the Next Generation Supercomputer (10PF machine).

• More collaboration of computer scientists and application scientists is needed.
Observations (4/4)

• International Collaboration:
  – Competitiveness and collaboration

• Earth Simulator:
  – 10% of the resource was reserved for the Director and was used for international collaboration.

• NG Machine:
  – No decision is made in this respect.
  – IMHO, some part should be used for international collaboration under mutual agreement.