NEC HPC Strategy and Products

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NEC Corporation
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Supercomputer Performance Gains

FLOPS (Peak)

Peta $10^{15}$

Tera $10^{12}$

Giga $10^9$

Mega $10^6$

- NEC Earth Simulator 2002 40TF
- NEC SX-2 1983 1.3GF
- Cray-1 1976
- CDC6600
- ENIAC 1946, 300FLOPS

+75%/year

+47%/year
No.1 Vector Supercomputer in the World

Over 1000 SX systems (cumulative orders)

Example of Users

Europe
- The Met Office (United Kingdom)
- Meteo France (France)
- Danish Meteorological Institute (Denmark)
- German Climate Computing Center (Germany)
- CHMI (Czech)
- University of Stuttgart/HLRS (Germany)
- CNRS/IDRIS (France)
- Swiss Center for Scientific Computing (Switzerland)
- Aerospace Laboratories
  (Netherlands, Germany, France, Italy)

Japan
- Tohoku University Information Synergy Center
- Osaka University Cyber Media Center
- National Institute for Environmental Studies
- National Institute for Fusion Science
- Meteorological Research Institute - JMA
- Central Research Institute of Electric Power Industry
- Japan Aerospace Exploration Agency
- Toyota Central R&D Labs., Inc.
- Nissan Motors

Asia Pacific/South America
- Bureau of Meteorology / CSIRO (Australia)
- Korea Institute of Science, Technology and Information (Korea)
- Meteorological Services of Singapore (Singapore)
- National Institute for Space Research (Brazil)

Sales (units) by region

- Japan 50%
- Europe 36%
- Others 14%

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NEC’s HPC Activity

NEC’s HPC Strategy and Products

Toward the Future of HPC
NEC’s Computer Product Strategy

Leveraging two key technologies:
High performance technology and Highly reliability technology

High Performance Technology

- Most advanced technology
  - High-speed/high-density VLSI
  - High-density packaging
  - High-efficiency cooling
  - High-speed interconnect
- Parallel processing technology
- Cluster control technology

High Reliability Technology

- VALUMO (Platform Technology)
  - Autonomy/Virtualization
  - Fault-tolerance
  - Continuous operation

Technology leader products:
Supercomputer, ACOS Mainframe, IPF Server/Blade Server, Express PC Server, IA ft/Blade Server, iExpress Network Server, iStorage, DVD

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NEC’s Strategy on HPC

- **SX**: Vector supercomputer based HPC system
  - Overwhelming sustained performance and high reliability with NEC original cutting edge technologies
  - Ever-increasing per Core (CPU) performance
  - Seamless connection with other servers

- Right platform for right application, which best fits the customers’ needs
  - SX
  - SX+Scalar
  - Scalar
    - IPF scalar server
    - PC cluster

- Integrated NEC HPC solution
NEC’s HPC Products Lineup

- Vector Supercomputers
  - SX
- Scalar Servers
  - IPF Scalar Server
  - IPF Blade Server
  - PC Cluster (IA Server Cluster/IA Blade Server)
  - IA Workstation

- Supercomputer
  - SX Series
  - TX7 Series
- Other Platforms
  - EMС
  - Hitachi
- GFS (Global File System)
- FC-SW
- Express5800/50 Series
- Rackmount Blade
- Express5800/1020Ba (IPF Blade)
- PC Cluster
- NEC iStorage

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SX Innovation

Continual Break-Through Achieved in both Technology and Architecture

Architecture

- SX-8R
- SX-8
- SX-6
- SX-5
- SX-4
- SX-3
- SX-2

Technology

- Super large cluster (>500 nodes)
- Large cluster (>100 nodes)
- Single chip vector processor
- 1 node-module

SX Innovation

Single node >1GFLOPS

Multi Processor

- Multi nodes (>10 nodes)

1 node-module

CMOS Air-cooling

Through Achieved in both Technology and Architecture

- Bipolar Water Cooling

U can change.

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SX-8R Product Highlights

1. World’s fastest vector supercomputer with maximum performance of 144 TFLOPS
   - Very large scale: Up to 512 nodes, 4,096 CPUs
   - Very large memory / memory bandwidth: 256TB / 288TB/s
   - High speed data transfer between nodes: 8TB/s in total

2. High-density packaging with state-of-the-art technology
   - Single-chip vector processor with 35.2GFLOPS performance
   - Leading-edge CMOS technology with 90-nanometer process /copper interconnects
   - Single-module node with 281.6GFLOPS performance

3. Enhanced SUPER-UX / Tuned applications
   - Proven operating system for SX series enhanced to expand scalability
   - A lot of ISV application programs tuned for SX series available
SX-8R Enhancement

- Vector adder and multiplier **doubled**
  - SX-8 : \( \text{(Multiply + Add)} \times 4\text{pipes} \times 2\text{GHz} = 16\text{GF} \)
  - SX-8R: \( \text{(Multiply + Add)} \times 2\text{sets} \times 4\text{pipes} \times 2.2\text{GHz} = 35.2\text{GF} \)

- Memory capacity is **doubled**
  - SX-8
    - 128GB
  - SX-8R
    - 256GB/node (DDR2 RAM)
    - 64GB
    - 128GB/node (FCRAM)

- Clock-up
  - 2.2GHz (10% up)
  - note: **ONLY FOR DDR2 models**
    - FCRAM model’s clock cycle remains with 2GHz.
Comparison of CPUs (SX-8, SX-8R)

SX-8

4 Vector pipelines

Load or Store

Vector Reg.

Mask Reg.

Mask

logical

Multiply

Add

Div./Sqrt

Scalar Unit

Cache

Scalar Reg.

Scalar Exec.

SX-8R

4 Vector pipelines

Load or Store

Vector Reg.

Mask Reg.

Mask

Mult./Log

Multiply

Add

Add./Div./Sqrt

Scalar Unit

Cache

Scalar Reg.

Scalar Exec.

Note: One vector instruction occupies one vector pipeline on SX-8R.

e.g.) The peak performance of one VFAD (vector FP add) Op. is 8.8GFLOPS

2(M+A) x 4vpp x 2GHz = 16GFLOPS

2(M+A) x 2set x 4vpp x 2.2GHz = 35.2GFLOPS
SX-8R Single Node Module (DDR2 model)

- **Up to 8 CPUs/node**
  - Peak Vector Performance (PVP): 35.2 GFLOPS/CPU, 281.6 GFLOPS/node
- **Symmetric multiprocessing (SMP)**
- **Large Capacity Memory**
  - Up to 256GB
- **Ultra-high memory bandwidth**
  - 70.4GB/s per CPU
  - Total 563.2GB/s per node
- **Large I/O throughput**
  - 12.8GB/s per node
High speed processing of large data with high performance single node, large number of nodes, and high speed interconnects among nodes

Key points for high performance

1. Single node performance
   Max 281.6GFLOPS

2. Maximum number of nodes
   Max 512 nodes

3. Data transfer rate among nodes
   Max 8TB/s
   (Peak data transfer rate)

High speed inter-node switch (IXS)

Max 8CPU 281.6GFLOPS

Optical Interconnection

Max 8CPU 281.6GFLOPS

Max 512 nodes
IPF Server Roadmap

- **CY2001**: Itanium
  - July 2001 TX7/AzusA Announcement
  - 51.2GFLOPS /16CPU

- **2002**: Itanium2
  - July 2002 TX7/i9000 release
  - 128GFLOPS /32CPU

- **2003**: Itanium2 6M
  - 192GFLOPS /32CPU

- **2004**: Madison 9M
  - 204.8GFLOPS /32CPU

- **2006**: Montecito
  - AsAmA2
  - 409.6GFLOPS /64CPU

Node Performance (peak GFLOPS)

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Platform for PC Cluster

Enable to choose Optimized server depending on usage and budget

**Opteron/Xeon Rack**
Express5800/T220Rc-1 (Opteron)
Express5800/T120Rb-1 (Xeon)

**Express5800/100 series, Opteron server**
Cost performance Opteron/Xeon server
Good price/performance ratio. More memory slots achieve system cost reduction.

**Xeon Blade**
Express5800/120Ba-4

**Express5800/BladeServer**
High density & Cost performance Xeon blade
Higher density than competitors. PCI slots achieve expandability.
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Processor Architecture

Scalar Processor

Vector Processor

Scalar ALU

Vector ALU (SIMD)

ADD High Speed Engine (Vector)

Pentium 4

Cell

SX-8
Performance acceleration trend

Processor core architecture

① Expand SIMD units
② Add-on Co-Processor
③ Heterogeneous multi-core

Performance of HPC Processors accelerated by using SIMD/Vector extension approach
Trend of Processor Multi core Chip

HPC Processors will take in Vector units on the CPU die.

Scalar Machine       Add Vector (SIMD) Function   Future

X86

AMD

Cell

SONY

IBM

TOSHIBA

X86

Multi core

S+ Vector 

S+Multi Vector

S+V Multi core

Vector Machine

SX

NEC

S+V Single core

(S+V) Multi core

U can change.
Core Technologies for Future Supercomputer

**Hybrid System**
- Vector
- Scalar
- Special

**Low Power Consumption**
- Power density will go up like Nuclear Reactor.
- Low Power consumption and cooling technology will be required.

**Interconnect**
- Transfer speed between LSIs will influence the sustained performance
- Optical Transmission Technology between LSIs will be required.

**Software**
- Super Parallel Software
- Super large data handling

Selection of the suitable platform by applications
Realize high sustained performance for various applications

>10,000CPU

>1 Petabyte

U can change.
NEC continues to supply best product to customers through the ceaseless quest for technology and by Being a quality leader in the world

Thank you!!