Introduction of Fujitsu’s next-generation supercomputer

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Fujitsu has a long history of supercomputing over 30 years.

Technologies and experience of providing several types of supercomputers such as vector, MPP and cluster, are inherited and implemented in latest supercomputer product line.
K computer and Fujitsu PRIMEHPC series

- Single CPU/node architecture for multicore
  - Good Bytes/flop and scalability
- Key technologies for massively parallel supercomputers
  - Original CPU and interconnect
  - Support for tens of millions of cores (VISIMPACT*, Collective comm. HW)

**FX1**
VISIMPACT
Collective comm. HW

**K computer**
SIMD extension HPC-ACE
Direct network Tofu

**FX10**
HPC-ACE
Direct network Tofu

**Post-FX10**
HPC-ACE2
Tofu interconnect 2
HMC & Optical connections

*VISIMPACT: Virtual Single Processor by Integrated Multi-core Parallel Architecture*
Architecture continuity for compatibility

- Upper compatible CPU:
  - Binary-compatible with the K computer & PRIMEHPC FX10
  - Good byte/flop balance

- New features:
  - New instructions (stride load/store, indirect load/store, permutation, concatenation)
  - Improved micro architecture (out-of-order, branch-prediction, etc.)

- For distributed parallel executions:
  - Compatible interconnect architecture
  - Improved interconnect bandwidth
# The K computer and the evolution of PRIMEHPC

<table>
<thead>
<tr>
<th></th>
<th>K computer</th>
<th>PRIMEHPC FX10</th>
<th>Post-FX10</th>
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</thead>
<tbody>
<tr>
<td><strong>CPU</strong></td>
<td>SPARC64 VIIIfx</td>
<td>SPARC64 IXfx</td>
<td>SPARC64 XIfx</td>
</tr>
<tr>
<td><strong>Peak perf.</strong></td>
<td>128 GFLOPS</td>
<td>236.5 GFLOPS</td>
<td>1TFLOPS ~</td>
</tr>
<tr>
<td><strong># of cores</strong></td>
<td>8</td>
<td>16</td>
<td>32 + 2</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>DDR3 SDRAM</td>
<td>HMC</td>
<td></td>
</tr>
<tr>
<td><strong>Interconnect</strong></td>
<td>Tofu Interconnect</td>
<td>Tofu Interconnect 2</td>
<td></td>
</tr>
<tr>
<td><strong>System size</strong></td>
<td>11PFLOPS</td>
<td>Max. 23PFLOPS</td>
<td>Max. 100PFLOPS</td>
</tr>
<tr>
<td><strong>Link BW</strong></td>
<td>5GB/s x bidirectional</td>
<td>12.5GB/s x bidirectional</td>
<td></td>
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</table>

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Feature and Configuration of Post-FX10

**Fujitsu designed SPARC64™ XI fx**
- 1TF~(DP)/2TF~(SP)
- 32 + 2 core CPU
- HPC-ACE2 support
- Tofu2 integrated

**Chassis**
- 1 CPU/1 node
- 12 nodes/2U Chassis
- Water cooled

**CPU Memory Board**
- Three CPUs
- 3 x 8 Micron’s HMCs
- 8 Finisar’s opt modules, BOA, for inter-chassis connections

**Tofu Interconnect 2**
- 12.5 GB/s×2(in/out)/link
- 10 links/node
- Optical technology

**Cabinet**
- 200~ nodes/cabinet
- High-density
- 100% water cooled with EXCU (option)
Flexible SIMD operations

- New 256bit wide SIMD functions enable versatile operations
  - Four double-precision calculations
  - Stride load/store, Indirect (list) load/store, Permutation, Concatenation

- 128 registers
- Simultaneous calculation
- Double precision
- Memory
  - Specified stride
  - Arbitrary shuffle
- Reg S
- Reg D
Tofu Interconnect 2

- Successor to Tofu Interconnect
  - Highly scalable, 6-dimensional mesh/torus topology
  - Increased link bandwidth by 2.5 times to 12.5 GB/s
- Interconnect integrated into CPU
  - System-on-chip (SoC) removes off-chip I/O
  - Improved packaging density and energy efficiency
- Optical cable connection between chassis

Scalable three-dimensional torus

Three-dimensional torus unit
2×3×2

Well-balanced shape available

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Entire software stack is enhanced for Post-FX10

**Applications**

**HPC Portal / System Management Portal**

**Technical Computing Suite**

**System Management**
- System management
- System control
- System monitoring
- System operation support

**Job Management**
- Job manager
- Job scheduler
- Resource management
- Parallel

**High Performance File System**
- Lustre based high performance distributed file system
- High scalability, high reliability and availability

**Automatic parallelization compiler**
- Fortran
- C
- C++

**Tools and math libraries**
- Programming support tools
- Mathematical libraries

**Parallel languages and libraries**
- OpenMP
- MPI
- XPFortran

**Linux based OS (enhanced for FX series)**

**PRIMEHPC FX series**

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Fujitsu has a long history of supercomputing since early 1980.

Technologies and experience of providing several types of vector, MPP, and cluster supercomputers are inherited and implemented in our latest supercomputer product line.

- **K computer**
- **F230-75APU**
- **Japan's First Vector (Array) Supercomputer (1977)**
- **SPARC64 VIII fx**
- **SPARC64 IX fx**
- **FUJITSU Supercomputer PRIMEHPC FX10**
- **Exascale**

**Post-FX10**

- **SPARC64 XI fx**

**100 Pflops class**

- **20 Pflops class**

**10 Pflops class**

**2015**

- **100 Pflops class**
- **Post-FX10**

**2020**

- **Exascale**

- **PRIMEPOWER**
- **HPC2500**

- **World’s Most Scalable Supercomputer (2003)**

- **Japan’s Largest Cluster in Top500 (July 2004)**

- **Highest Performance efficiency in Top500 (Nov. 2008)**

- **PRIMEHPC FX10**

- **No.1 in Top500 (June and Nov., 2011)**

- **Fujitsu PRIMERGY BX900**
- **Cluster node**

- **HX600**

- **PRIMEQUEST FX1**

- **SPARC**

- **Enterprise**

- **PRIMERGY RX200**
- **Cluster node**

- **SPARC**

- **Fujitsu AP1000**

- **VPP500**

- **VPP1000**

- **VPP300/700**

- **AP3000**

- **VP Series**

- **NWT**

**Numerical Wind Tunnel**

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