Designing for the Future –
GPU Solutions that Maximize Performance, Density and Energy Efficiency

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Supermicro Profile

Global Footprint: >80 Countries
Years Profitable: 21 Years (since day one, 1993)
Production: Facilities in the US, Asia and EMEA
Customers: Channel, SI/VAR, OEM direct
Corporate Focus: Architecture Innovation, Energy Efficiency, Total Solution
HPC Trend: > 80% HPC sites have been using processor/co-processor/accelerator for either exploratory or production (IDC: grows from 28.8% 2011 to 76.9% 2013)

Performance and Efficiency (performance per watt): 17 of the top Green500 list in June’14 are GPU/Co-processor accelerated HPC systems

Moving to the Top: the greenest supercomputer on the Green500 list is TSUBAME-KFC submerged GPU cluster: >4 MFLOPS/w

Wide Adoption: GPU applications are beyond HPC: such as Finance, Gaming, Vitalization (E.g. VDI)...
GPU Computing Beyond HPC

**Scientific**
- Computational fluid dynamics
- Materials science
- Molecular dynamics
- Quantum chemistry

**Data Mining**
- Data parallel mathematics
- Extend Excel with OLAP for planning & analysis
- Database and data analysis acceleration

**Oil and Gas/Seismic**
- Seismic imaging
- Seismic Interpretation
- Reservoir Modeling
- Seismic Inversion

**Weather and Climate**
- Weather
- Atmospheric
- Ocean Modeling
- Space Sciences

**Imaging and Computer Vision**
- Medical imaging
- Visualization & docking
- Filmmaking & animation

**Computational Finance & simulation**
- Options pricing
- Risk analysis
- Algorithmic trading

**Simulation & Creation Design**
- Mechanical design & simulation
- Structural mechanics
- Electronic Design Automation

**Entertainments**
- Online gaming (Gaming Grid)
- Movie rendering / animation
- Video streaming / image processing

**Massively parallel architecture accelerates scientific & engineering applications**
GPU GRID for Virtualization, Gaming & Enterprise

- Industry’s most comprehensive, power efficient and densest GPU solutions
- The first NVIDIA GRID-certified GPU-systems on the market
Supermicro GPU Solution Evolution

The most comprehensive product line in the Industry

GPGPU Where it started...

Telsa S1070

Hybrid Computing Pioneer

1U 4-GPU Standalone box

GPGPU 4 GPUs Workstation / 4U

Efficiency

The fastest 1U server in the world

Ultra High Efficiency

Density

FatTwin™ 2-node 6 GPUs or MICs per node

2U 4-GPU

4 GPUs Workstation / 4U

1U 3-GPU

X9 (UP) 1U 2-GPUs

7U GPU Blades 20 CPUs + 20 GPUs

FatTwin™ 4-node 3 GPUs per node

2U Twin

1U 4-GPUs

1U 4-GPUs

3 GPUs Blade

FatTwin™ 2-GPUs

2U 6-GPUs

Where it started...

Efficiency

Density

Mainstream

2008

2009

2010

2011

2012

2013

2014
GPU Optimized System Lineup

- **SuperServer (Passive Cooling)**
  - **1U UP – Value**
    - 1017GR-TF
    - 5017GR-TF
  - **1U/2U DP – Scalable, High Density**
    - 1027GR-TQF
    - 1027GR-TQFT
    - 2027GR-TRFH
    - 2027GR-TRFHT
  - **3U & Above – Performance**
    - 7047GR-TPRF
    - FatTwin
    - 6037R-72RFT+
    - SuperBlade

- **Workstation (Active Cooling)**
  - 5037A-iL
  - 5037A-i
  - 7037A-iL
  - 7037A-i
  - 7047A-T
  - 7047GR-TRF
Designing GPU Optimized Systems

- **Performance**
  - PCI-e lanes arrangement, PCB placement, interconnection…
  - CPU, MEM, I/O, Networking, Storage…

- **Mechanical design**
  - mounting, location, space utilization

- **Thermal**
  - air flow, fan speed control, location, noise control

- **Power supply**
  - PSU efficiency, wattage options, power monitoring & management
  - Number of power connectors (& location)
Design for Performance

Platinum level high efficient 1800W power supply
Communication Between GPUs

The model used by existing CPU-GPU Heterogeneous architectures for GPU-GPU communication. Data travels via CPU & Infiniband (IB) Host Channel Adapter (HCA) and Switch or other proprietary interconnect.

Data transfer between cooperating GPUs in separate nodes in a TCA cluster enabled by the PEACH2 chip.

Schematic of the PEARL network within a CPU/GPU cluster

Source: Tsukuba University
Power Supply

- High efficiency power supplies
  - 95% platinum
  - Wattage choices & configurability
  - Redundancy & BBP support
- Power management software
  - Power capping
  - Core speed control for power management
Platinum/Titanium (95%+) Digital Power Supply

Digital Switching Power Supplier (95+%)

* maintain high efficiency even at low loading

Max. Power Requirements

<table>
<thead>
<tr>
<th>PSU Loading</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No GPU</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 GPU</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 GPUs</td>
<td></td>
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<tr>
<td>3 GPUs</td>
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<tr>
<td>4 GPUs</td>
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<tr>
<td>5 GPUs</td>
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<td></td>
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<tr>
<td>6 GPUs</td>
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</tbody>
</table>

Efficiency Comparison

Power Factor Comparison
Configurable Power Supplies

- Standardize power supply module
- Design multiple capacity options (240W ~ 2000W)
- Provide application-optimized & energy-efficient configurations
- Feature power management / control

SUPERMICRO®
High-Efficiency (95%+) Digital Switching Power Modules

www.supermicro.com/PowerSupplies
Thermal & Cooling Design

- Heatsink performance
- Passive & active
- High-performance Fan
- Fan speed control
- Multiple zones sensors
- Air shroud design
- Liquid cool
Optimized Airflow and Configurable Cooling

Workstation / 4U Server
(Accommodates both Active and Passive)

- Consider total system-cooling design
- Remove unnecessary cooling component
- Enforce the hot zone airflow
- Provide application-optimized & energy-efficient configurations
Water Cooling Example

Rack DCLC AHx™ - components used in the self-contained rack (CoolIT®)

AHx Module
- Dual redundant fans
- Centralize pumping architecture
- CoolIT Command Center monitors/alerts on health of liquid system

Manifold Module
- Steel body attaches similar to PDU
- All-metal dry-break quick connects

Server Module
- Passive cold plate technology
- All-metal dry-break quick connects

- Example configuration: FatTwin GPU, 4U 4-node – 3 GPUs per node
- Can be used in any form factors – 1U, 2U, 4U... GPU systems
- Cold plates for CPUs and GPUs
- Very low system fan speed for cooling other components

FatTwin™ GPU node

Cooling the both the CPUs and GPUs
Case Study – Submerged Liquid Cooling

✓ Removed Fans and Heat Sinks
✓ Use SSD & Updated BIOS
✓ Reverse the handlers

“Submerged Supermicro Servers Accelerated by GPUs”

- Supermicro 1U with
- No requirement for room-level cooling
- Operates at PUE ~ 1.12
- 25 kilowatts per rack – the breakpoint per rack
  (between regular air-cool and submerged cool)

Cost Efficiency

<table>
<thead>
<tr>
<th></th>
<th>Air cool</th>
<th>Submerged liquid cool</th>
</tr>
</thead>
<tbody>
<tr>
<td>KW / rack</td>
<td>~25kW</td>
<td></td>
</tr>
</tbody>
</table>

Cost Efficiency Chart:

- Removed Fans and Heat Sinks
- Use SSD & Updated BIOS
- Reverse the handlers

Submerged Supermicro Servers

Accelerated by GPUs
Green500 #1

Green Top-17 all employ Heterogeneous GPU Architectures

http://www.supermicro.com/products/nfo/Green500.cfm

Top500 #311 (~4.5GFLOPS per Watt)

Tokyo Institute of Technology

This certificate is in recognition of your organization's achievements in reducing the environmental impact of high-performance computing.

GSIC Center, Tokyo Institute of Technology

is ranked

1st

on the world's Green500 List of computer systems as of

November 2013

Heterogeneous GPU Architectures
Summary

- A new era of hybrid computing – heterogeneous architecture with GPU / coprocessor acceleration

- There are more to come in the industry roadmap with new technologies, power management features and system architectures

- The trend towards heterogeneous architecture poses many challenges for system builders and software developers in making efficient use of the computing resources

- Configurable cooling & power for energy efficiency and performance are the key to optimized the GPU systems

- Specialized (or application-optimized) design is required for GPU Applications efficiency and scalability

- Supermicro offers the most comprehensive line of solutions supporting the full spectrum of GPU computing applications
Thank you!

SuperServer® FatTwin™ and SuperBlade® GPU Platforms
HPC, Enterprise Virtualization, Visual Computing and Cloud Gaming at NVIDIA GTC 2014

4U SuperServer®
8x GPU
NVIDIA® Iray VCA Platform
SYS-4027GR-TRF/FRF

4U/Tower
5x GPU
NVIDIA Maximus™ Certified
SYS-7047AX-1RF

4U Hyper-Speed
1x GPU
Low-Latency Optimized
SYS-7047AX-1RF

30x GPU
7U SuperBlade®
3x GPU
SBI-7127RGE

7U SuperBlade®
20x GPU
7U SuperBlade®
2x GPU
SBI-7127RG-0-E

4U 2-Node FatTwin™
12x GPU
6x GPU per node
SYS-P647G2-FT+/PTP+K20X/K40X

SuperServer®
2x GPU
SYS-2027GR-TRFB/

SuperServer®
6x GPU
SYS-4037R-TRFB+

SuperServer®
3x GPU
2U SYS-2027GR-TRFB/

SuperServer®
3x GPU
1U SYS-1027GR-TRF/

SuperServer®
3x GPU
1U SYS-1027GR-TRF/

SuperServer®
2x GPU
1U SYS-1017GR-TR/

www.supermicro.com/GPU