Leibniz Supercomputing Centre

Liquid Cooling Commissioning Lessons Learned @LRZ

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EE HPC WORKING GROUP, SC13, Denver, Nov. 17-22, 2013
Leibniz Supercomputing Centre

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<thead>
<tr>
<th>Munich</th>
<th>Bavaria</th>
<th>Germany &amp; Europe</th>
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<tbody>
<tr>
<td>• We provide generic IT services to all Munich universities</td>
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<td>• We provide special IT services to all universities in Bavaria</td>
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<td>• Network, High Performance and Grid Computing</td>
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<td>• Backup and Archive Services</td>
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<td>• IT Management</td>
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<td>• We provide supercomputing resources to scientists in Europe</td>
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<td>• Member of the German Gauss Supercomputing Centre</td>
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<td>• Third party of the European HPC Infrastructure PRACE</td>
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<td>• PRACE Tier-0 Supercomputing Center (SuperMUC system)</td>
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<td>• Investigations on Future HPC Systems:</td>
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<td>• Hardware Architectures</td>
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<td>• Programming Models &amp; System Software</td>
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<td>• Zero Emission Data Center Infrastructures</td>
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<td>• Re-Use of Waste Heat</td>
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Data Center Infrastructure

Some more Facts

- **3160.5 m² (34 019 ft²)** IT Equipment Floor Space (6 rooms on 3 floors)
- **6393.5 m² (68 819 ft²)** Infrastructure Floor Space
- **2 x 10 MW** 20kV Power Supply
- **Powered Entirely by Renewable Energy**
- **> 300 000€ (~ 400 200 US$)** Electricity Costs per Month
SuperMUC: IBM System x iDataPlex With Direct Water Cooling

2897 TFlop/s HPL Performance
Rank 4 (June 2012)
Rank 6 (November 2012)
Rank 9 (June 2013)

iDataplex DWC Rack w/ water cooled nodes
(rear view of water manifolds)
Heat Profile of SuperMUC (2/2013)
CASE #1: Cooling Towers
Malfunction of Water Level Sensors

- **Issue:**
  - Water demand cooling loop increased
    - Filling volume: 7 m³
    - Typical feed: 1+ m³/h
    - Observed losses: 1 – 2 m³ in hours or days

- **Investigations:**
  - Load tests of the cooling towers
  - Inspection of the control system
  - Examination of the measuring devices

- **Reason:**
  - Wrong dimensions of the filling level sensor installed

- **Root cause:**
  - Main contractor did not use the sensor recommended by the manufacturer of the cooling tower
CASE #2: Operating Control
Warm Water Cooling Infrastructure
Operating Control: Test of $\Delta T_{\text{inlet}}(\text{NSR}) = -20$ K
Response of Warm Water Cooling Infrastructure
Operating Control: Test of $\Delta T_{\text{inlet}}(\text{NSR}) = -20 \, \text{K}$

Response of Warm Water Cooling Infrastructure
WWW.SIMOPEK.DE
Thank You!

Zero Emission Supercomputing Centre
Energy Efficient HPC: The Four Pillar Model

Data Center (Goal: Reduce Total Cost of Operation)

- **Goal:** Improve PUE (Power Usage Effectiveness)
  - **Building Infrastructures**

- **Goal:** Reduce Hardware Power Consumption
  - **HPC System Hardware**

- **Goal:** Optimize Resource Usage, Tune System
  - **HPC System Software**

- **Goal:** Optimize Application Performance
  - **HPC Applications**

**Global Optimization Strategy**