Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Vinod Kamath
Power and Thermal Engineering
IBM Systems and Technology Group
Sep 16, 2005
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Problem Statement
• Rack Power loads are high due to increased compute density.

• The impact is seen in datacenters as high inlet air temperatures to the equipment.

• Datacenter flow balancing issues can create local hotspots as well.

• The consequence can be lowered system reliability and failures.

• High fan and blower speeds can be seen due to higher inlet temperatures.

• Added acoustics signatures of equipment can create user discomfort.

• Exit air temperatures from servers can be 50 deg C or higher

Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Solution Characteristics

• Localized spot treatment required

• Heat exchange with exit air provides the most efficient mechanism for temperature reduction

• A low airflow pressure drop solution can provide a "passive mechanism" for heat extraction

• Small footprint impact on existing datacenters of design.
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Solution Details

• Replace an existing Rear Door with a heat exchanger

• The footprint increase is about 5.6" on the rack

• Uses existing hinge and latch assemblies with > 90 deg C open capacity

• Water delivered using 3/4" ID supply and return hoses

• Industry standard quick connect hydraulic couplings to door
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Salient Features

• The heat exchanger is a tube-and-fin design with low air side pressure drop
• Operates using above dew point water
• Robust quality control in the braze process and build process
• Door design enables high strength-weight ratio (70 lb.)
• Protective barriers to fins
• Handles for Install
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Rear Door Heat Exchanger
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Standalone Performance

- Rack Level Testing with high power density servers
- Bladecenters were used in the rack
- Functional 1U servers were used as well to determine heat extraction
- The tests were conducted in a room where the inlet temperature could be maintained between 23-25 deg C.
- The water flow rate was maintained at 7 GPM in the test cases and the water inlet temperature was kept at 17 deg C
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Test Results

• The results for the BladeCenter and 1U rack servers show between a 50% to 60% heat extraction of the input heat load.

• The increase in airflow impedance to the servers can result in a marginal 1 deg C impact to the CPU temperatures due to a slight flow loss to the servers.

• The exit air temperature from the RDHX is reduced by an average of 25 deg C from the discharge end of the servers.
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Blade Center Tests

• Thermal Load Blade (250W-450W)
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

Blade Center Tests

- 6 BladeCenter Chassis
- 5 Thermal Equivalent Chassis, 1 Functional Chassis
- Thermal Blade with Calibrated impedance and power
- Each Unit Calibrated to determine airflow and power
- Functional tests run at different airflow rates and power loads
- Data at 1530 CFM (approach flow)
- Water Flow at 7 GPM

<table>
<thead>
<tr>
<th>Rack Power (kW)</th>
<th>Air Inlet to Rack (°C)</th>
<th>Water Inlet (°C)</th>
<th>Water Outlet (°C)</th>
<th>Heat Extraction (kW)</th>
<th>Efficiency (% age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.3</td>
<td>26.8</td>
<td>17.3</td>
<td>23.4</td>
<td>12.02</td>
<td>49.9</td>
</tr>
<tr>
<td>31.5</td>
<td>24.5</td>
<td>17.1</td>
<td>26.9</td>
<td>18.12</td>
<td>49.9</td>
</tr>
</tbody>
</table>

IBM Systems and Technology Group
Rear Door Heat Exchanger
A method for DataCenter Thermal Management

1U Tests

- 40 - x336 1U with Xeon 2.8 GHz CPUs
- 5 GPM Water at 17 deg C
- Measured Power 10.6 kW for Rack

<table>
<thead>
<tr>
<th>Rack Power (kW)</th>
<th>Air Inlet to Rack (C)</th>
<th>Water Inlet(C)</th>
<th>Water Outlet(C)</th>
<th>Heat Extraction (kW)</th>
<th>Efficiency (% age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.6</td>
<td>24.5</td>
<td>18.3</td>
<td>22.8</td>
<td>5.94</td>
<td>56.0</td>
</tr>
</tbody>
</table>

IBM Systems and Technology Group