

Energy Smart Data Center Phase II

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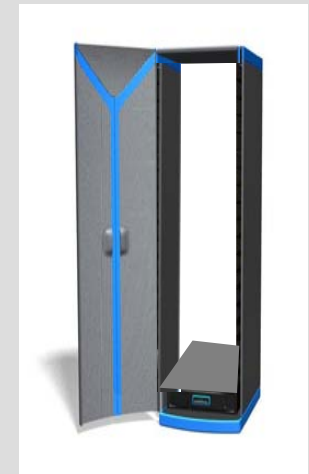
Objectives of ESDC Phase II

- ▶ **Promote maturation** of spraycooling technology
 - Spot spraycooling technology
 - Global spraycooling technology
- ▶ **Experiment** with spraycooling technology in the HPC realm
- ▶ **Promote adoption** of spraycooling technology by HPC OEM vendors
- ▶ **Investigate new technologies** enabled by spraycooling
- ▶ **Update and create new models** (COP/TCO) originally developed in Phase I
- ▶ **Promote cooperation** and **information sharing**
- ▶ **Plan** Phase III

Promote Maturation of Spraycooling Technology

- ▶ Deploy novel Thermal Management Unit (Enhanced M-Series:TomCat)
 - Capable of handling higher thermal heat loads (up to 14kW/30C)
 - Uses components with established industrial reliability track record (e.g., HX Niagara Thermal Products, 13L Speck pumps)
 - Lessons learned from Phase I integrated into the TMU design
 - ✦ Currently operational at ISR; expect PNNL deployment 07/06

- ▶ Deploy novel SprayCool rack (42 U), specially configured to host the TMU, the manifold in conjunction with the compute servers
 - Manifold, inlet, outlet, and valves designed into rack
 - Better serviceability
 - ✦ Currently operational at ISR; expect PNNL deployment 07/06



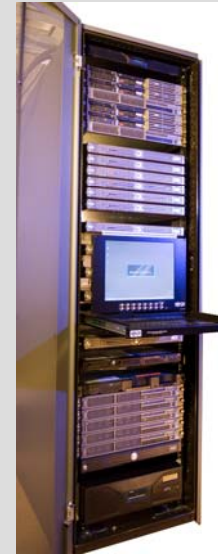
Promote Maturation of Spraycooling Technology

- ▶ Upgrade an air cooled 16 HP RX1620 1U server rack with spot spraycooling technology
 - Improves densification over Phase I 2U servers
 - ✦ Currently operational at ISR; expect PNNL deployment 07/06

- ▶ Design and demonstrate a 1U server reference design targeted for spot spraycooling technology
 - Reduces the number of fans
 - Improves layout of cooling technology, including plumbing and air-flow
 - Integrates server diagnostics system with TMU (IPMI)
 - Provides industry with a reference design
 - ✦ Expect PNNL deployment 08/06

- ▶ Scale global spraycooling technology by providing 4 additional blades populated with 4GB memory per CPU to run larger applications
 - ✦ First memory module prototypes running; expect PNNL deployment 07/06

- ▶ Improve workflows for maintenance and servicing
 - ✦ Continuing process



Experiment with Spraycooling Technology

- ▶ Run extensive burn-in tests on test systems
 - ☑ Burn-in test being performed at ISR
- ▶ Execute robustness tests in periodic intervals (mostly monthly) in valid specification ranges
 - ✦ To be done at PNNL
- ▶ Exercise test systems with benchmarks (Linpack, NPB)
 - ✦ To be done at PNNL
- ▶ Run real applications (NWChem)
 - ✦ To be done at PNNL

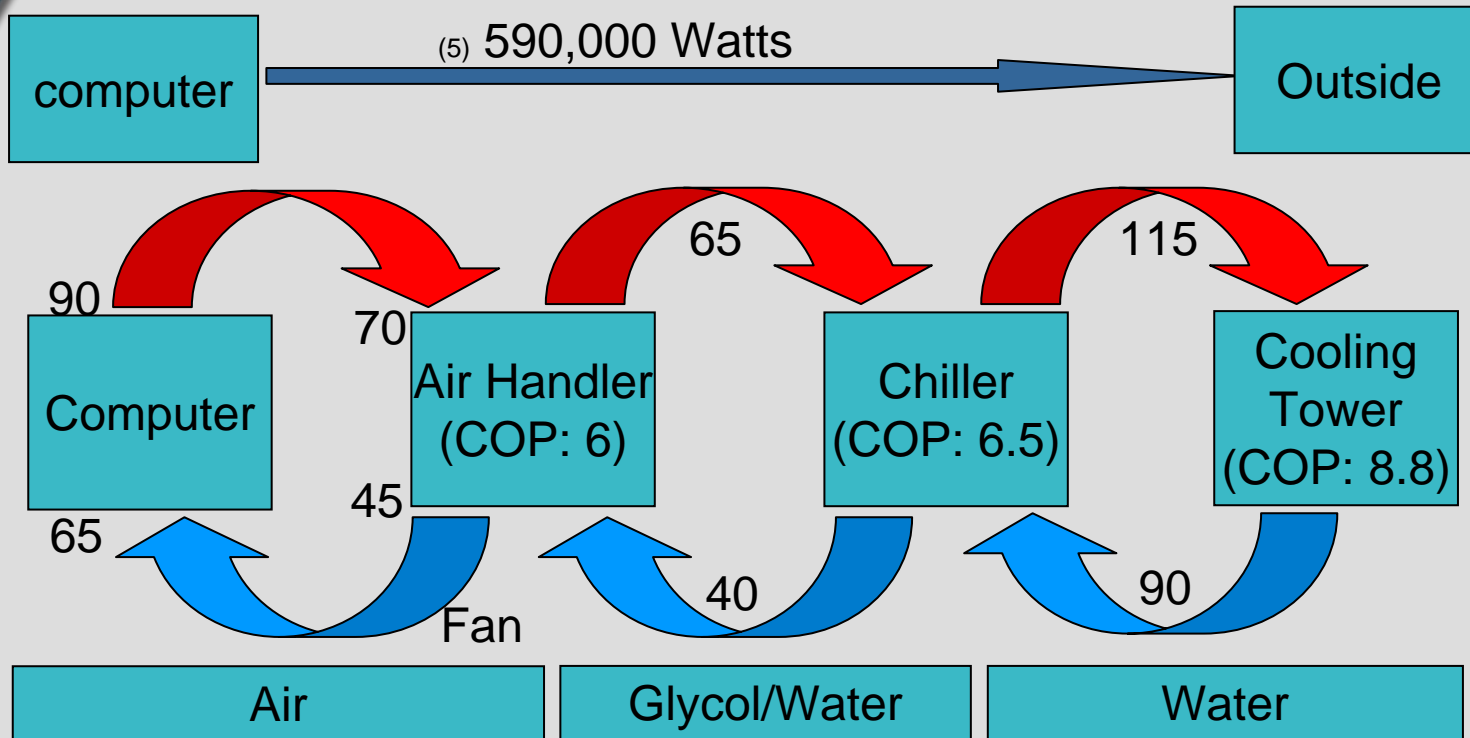
Promote Adoption of Spraycooling Technology

- ▶ HP has already quoted twice spraycooled systems
- ▶ SGI is strongly engaged with a common reseller
- ▶ ISR/DELL cooperation making progress
- ▶ IBM is showing increased interest in spraycooling technology; also in combination with their RDHx technology

Investigate New Technologies Enabled by Spraycooling

- ▶ Large Scale Coherent Memory Computer Study
 - Spraycooling enabling densified systems
 - ☑ First version of study completed; going through another revision
- ▶ 1U spot-spraycooled reference server design
- ▶ Trade studies:
 - Feasibility of constructing DC with reduced raised floors
 - Feasibility of spraycooling power infrastructure
 - ✦ In progress; expected report 08/06

Update Models



Total for Cooling:
292,500 W

COP =
590,000 /
297,500 ~
2.00

Total Energy:
887,500 W

(1) 25,500 Watts

Fans

(2) 36,000 Watts

CRAC Blowers

(3) 78,000 Watts

Pumps

(4) 91,000 Watts

Chiller

(7) 67,000 Watts

Pumps & Blowers

Promote Cooperation and Information Sharing

- ▶ LLNL
 - 12/05 Cader, Marquez: presentation to Mark Seger, Brent Gorda
 - 04/06 Marquez: phone briefing to Brent Gorda
- ▶ LBNL
 - 03/06 Cader, Regimbal: presentation to Bill Tschudi
 - 06/06 Marquez: phone conversation with Bill Tschudi
- ▶ NSA
 - 04/06 Marquez: Thermal and Power Aware Advanced Computing Systems: A Path to Densification
- ▶ SC'05
 - Global Chassis demonstration at PNNL booth
- ▶ Publications related to ESDC:
 - Panel on “High Density Microprocessor Cooling”
 - Cader, Regimbal, InterPACK 05
 - Air Flow Management in SprayCool Data Center
 - Cader, Westra, Regimbal, Mooney, ASHRAE 06
 - Next-Generation High Performance and Cooling Technologies
 - Regimbal, IDC 06
 - Performance of a Rack of Liquid-Cooled Servers
 - Cader, McAllister, Westra, Marquez, Regimbal, to appear ASHRAE 07
 - Total Cost of Ownership for a Liquid-Cooled Data Center
 - Cader, McAllister, Marquez, in progress, to appear in ASHRAE book

Planning Phase III

- ▶ Small scale Phase II technologies serve as a testbed for technologies deployed at large scale in Phase III
- ▶ Lessons learned during Phase I and II will be reflected in Phase III
- ▶ OEMs are on board to deploy spraycooling technology at larger scales

Summary Status Phase II

- ▶ Large Scale Coherent Memory Computer Study (first version finished, expect new version end 07/06)
- ▶ Deployment of 16 1U HP RX1620 with novel TMU in SprayCool rack (expect end 07/06)
- ▶ Demonstrate 1U server reference design (expect end 08/06)
- ▶ Scale global spraycooling technology to 8 boards with 4GB/processor (expect end 07/06)
- ▶ Feasibility Trend Studies (expect end 07/06)