Systems Two-Phase Cooling
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- Francis Krug – Mechanical Engineer

Total Project Cost: $3.3M
Length: 36 mo.
Project Vision – Dual Loop Two-Phase Cooling System

Develop Two-Phase Dielectric Cooling for Servers

- **Performance** – Low thermal resistance to reduce chip to ambient temperature delta
- **Energy Efficiency** – Heat transfer using coolant above ambient temperature enables COP > 30
- **Water Efficiency** – Eliminate cooling water usage $WUE = 0$
# Systems Two-Phase Cooling Overview

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<tr>
<th>Team member</th>
<th>Location</th>
<th>Role in project, core competencies</th>
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<tr>
<td>IBM Research</td>
<td>Yorktown Heights, NY</td>
<td>Two-Phase Cooling</td>
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<td>- Experimental Demonstrations – Evaporator designs</td>
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<td>- Modeling – Full-/Reduced-Physics and System-level models</td>
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<td>IBM Infrastructure</td>
<td>Poughkeepsie, NY</td>
<td>High End Server Two-Phase Cooled Product Development</td>
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<td>- Rack-level System Integration</td>
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<td>- Multi-server experimental demonstration</td>
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**Enabling features of our proposed technology**
- System component design based on high fidelity full/reduced-physics two-phase flow models
- System integration into a current product platform

**Bigger vision / Heat Transfer and System reliability summary**
- Pathway to Sustainable Computing: Two-Phase cooling enables energy efficient heat transfer and compute anywhere
- Non-conductive dielectric fluids prevent leaks from generating system damage (reduce risk severity)
- System integration for reliability and redundancy guided by zSystem water cooling data

**What is your envisioned goal/success criterion for your project**
- Product implementation of two-phase cooling to replace current cooling strategies
Systems Two-Phase Cooling Concept Detail

Supply Coolant: < 55 C
Rack Power Density: 22-55 kW/42U
PUE: < 1.03
WUE: 0
COP: > 30
Task Outline and Technical Objectives

Objectives

- Demonstrate robust two-phase cooling of a commercial computer system with multiple servers while varying power levels
- Develop and advance two-phase component and system models to inform designs and system configuration

Task 1 - Two-Phase Cooling Design Simulation

Task 2 - Two Phase Coldplate Development

Task 3 - Two Phase Cooling Loop Component Assessment

Task 4 - Demonstrate Two Phase Cooling for High End Servers

Task 5 - Technology to Market
Demonstrate Two Phase Cooling in IBM zSeries

Task 4 will design, integrate and demonstrate a two-phase cooled system, with components designed and selected from Task 2 and 3, on an IBM zSeries mainframe composed of 3 processor drawers with 12 dual-chip modules.

Design a two-phase cooling system which minimizes rack volume to target existing radiator unit footprint.

Radiator Cooling Assembly (RCA)
Technology-to-Market Approach

- The objective of this program is to demonstrate a system level two-phase cooling technology on a commercial high-end server to accelerate toward commercial adoption.

- The commercial transition of the proposed technology needs to be driven by:
  - A demonstration of the technology with proven performance, reliability, availability, and serviceability expected of the enterprise
  - End-user acceptance through a positive ROI in new and existing data centers.
  - The near-term market opportunity includes systems that currently deploy direct liquid cooling (e.g., high-end systems, supercomputers, and AI systems).

- Results of this program will be shared with the data center community, component suppliers, and modeling software companies to encourage commercial adoption of two-phase liquid cooling.
Needs and Potential Partnerships

- Please list any additional current needs for your project: resources, expertise, etc.
  
  - Development of advanced compact condensers beyond state of the art
    
    • High heat transfer coefficient (UA)
    • Low pressure drop
    • Compact form factor
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Q & A

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