ESTCP Project: Liquid Immersion Cooling of Electronics
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The Environmental Security Technology Certification Program (ESTCP) supported by the Department of Defense (DoD) is funding a demonstration of liquid immersion cooling being led by Lawrence Berkeley National Laboratory (LBNL). LBNL is partnering with 3M, Silicon Graphics International Corp., Naval Research Laboratory (NRL), Intel, and Schneider Electric to demonstrate this technology in performing high performance computing (HPC) at the Naval Research Laboratory (NRL) in Washington, DC.

Liquid immersion cooling of electronics is not a new concept; however, recent applications designed for high heat density computing have shown that this technology could play an important role in achieving energy efficient computing. With this technology, IT equipment is cooled by directly immersing it into a di-electric fluid. Initial applications are likely to occur first in HPC or other high heat density computing platforms since this technology has the ability to handle high heat density while providing a very efficient method for cooling the computing equipment. A typical data center site often consumes as much energy in the supporting infrastructure the vast majority of which is for cooling the computing equipment.

Immersion cooling drastically reduces the energy needed for the cooling portion of the infrastructure. Immersion cooling technology can reduce the energy consumed by the typical cooling processes by 90% or more thereby reducing the overall data center energy use on the order of 40%.

Currently, two well-known immersion cooling methods are: 1) convection heat transfer using a special mineral oil and 2) phase-change heat transfer using an engineered fluid.

The ESTCP demonstration is using SGI super computer equipment (the ICE™ X model) using Intel E5-2690 processors. The computer systems are immersed in a specially designed tank filled with a 3M engineered fluid (Novec 649) that provides efficient heat transfer by undergoing a phase-change.

A simplified diagram of the cooling circuit using Novec 649 fluid is shown (Figure 1). Heat is absorbed from the electronic components by the fluid changing state (from liquid to gas) on the surface of the heat producing components. Heat generated by the IT equipment is transferred to fluid circulating through condenser coils at the top of the tank, which allows the gas to be converted back to liquid droplets. The droplets fall back into the tank, pumping is not required. This local and direct heat transfer allows using a fluid at a temperature, much higher than usually found in data center cooling water systems. Allowing a warm cooling fluid temperature eliminates the operational energy and first costs required for compressor-based cooling (chillers) and cooling towers commonly used by data centers.

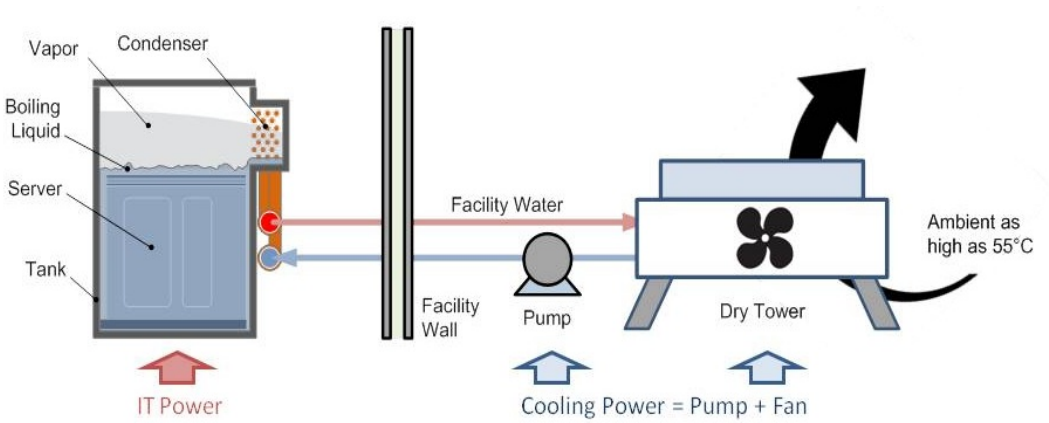

Figure 1: Simplified Schematic Of A Complete Immersion Cooling System

The demonstration is installed and beginning operation at the Naval Research Laboratory. The demonstration includes detailed energy and thermal measurements that will be recorded and analyzed over a period of time while NRL uses the system to perform normal HPC workloads. These measurements will be used to calculate overall efficiency and other metrics such as computational performance and immersion fluid evaporation. The tank is installed and the system is running at NRL (Figure 2).

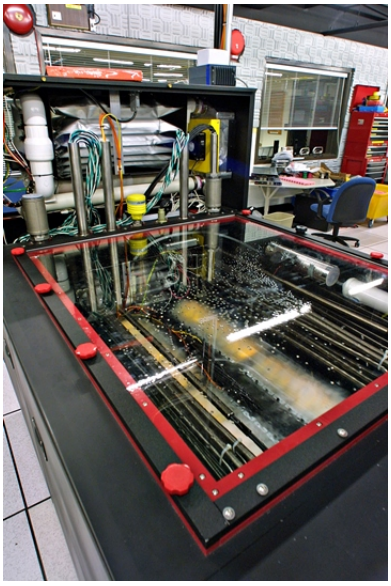

Figure 2: Immersion Cooling Installation at NRL

The goals of the project are to confirm efficiency, performance and financial attributes of using immersion cooling compared to standard cooling options. A report of the project is scheduled to be available in 2016.