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Experimental Assessment of Rack Level Dynamic direct to Chip Liquid Cooling for Data Center and IT Equipment Reliability

By

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Abstract

Data centers are used by organizations for storing, processing, and distribution of data. Due to increasing reliance on artificial intelligence, machine learning platforms, and cloud-based services, high-performance CPUs and GPUs are becoming ubiquitous. This further causes concern of efficient thermal management of these high-powered multi-chip modules for their reliable operation. An effective way of eliminating such cooling issues is direct to chip liquid cooling. Conventionally, this involves the supply of constant coolant flow (de-ionized water or refrigerants) through the servers irrespective of their instantaneous IT load. This redundancy in flowrate, especially at lower IT loads, causes excessive pumping power consumption. As a solution to this problem, a regulatory flow control device (FCD) and a flow control methodology are proposed to assist targeted delivery of coolant to the servers based on their IT load. Four high-power thermal test vehicles were placed in an ITE rack at different heights, mimicking high power processors in servers. A cold plate was placed on each of these thermal vehicles accompanied by pressure, temperature, and flow sensors. The FCD was placed downstream of the cold plate arrangement for dynamic flow regulation, based on the outlet temperature of the coolant of each of the cold plates. The flow to each of the test vehicle was monitored and varied based on the system pressure drop and the power supplied to the test vehicles. A significant impact of this novel strategy will be a reduction in the pumping power consumed by dynamically controlling coolant flow rates sufficient to dissipate high IT load instead of constantly dispensing coolant to all the servers. Also due to the varying flow rates, the servers sustaining higher loads are provided with higher flowrates, hence, potentially enhancing the reliability of the servers.