Spray and Air Cooling Comparison in High Density Servers

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As the power levels of high-performance microprocessors continue to rise, standard air cooling methods are failing to meet demands in many applications. As we move forward with Moore's Law, the limitations of air cooling combined with the trend toward denser packaging at the system level have created a significant problem. It is difficult to provide enough air flow to prevent processor throttling under high CPU loading in smaller 1U and 2U server form factors. This paper describes the potential of applying spray cooling technology to mitigate this problem by spot cooling the CPUs and remotely dissipating the heat from the multiple servers at the rack level. A side-by-side demonstration of air cooling and spray cooling performance in 1U and 2U dual Xeon 3.06-GHz servers was conducted. The temperatures of the CPU and other key system components were measured as a function of both CPU loading and operating ambient temperatures. It was determined that, with standard air cooling, the CPUs begin to throttle very near ambient temperature, and performance continues to decline as ambient temperature increases. The spray-cooled servers could be operated with no throttling in up to 50°C ambient environments if the same air flow rate is maintained through the server and up to 40°C with as little as 1/3 the air flow rate of the standard air-cooled server.