Electronics Energy & environment Power

Spray cooling system takes the heat out of data centres

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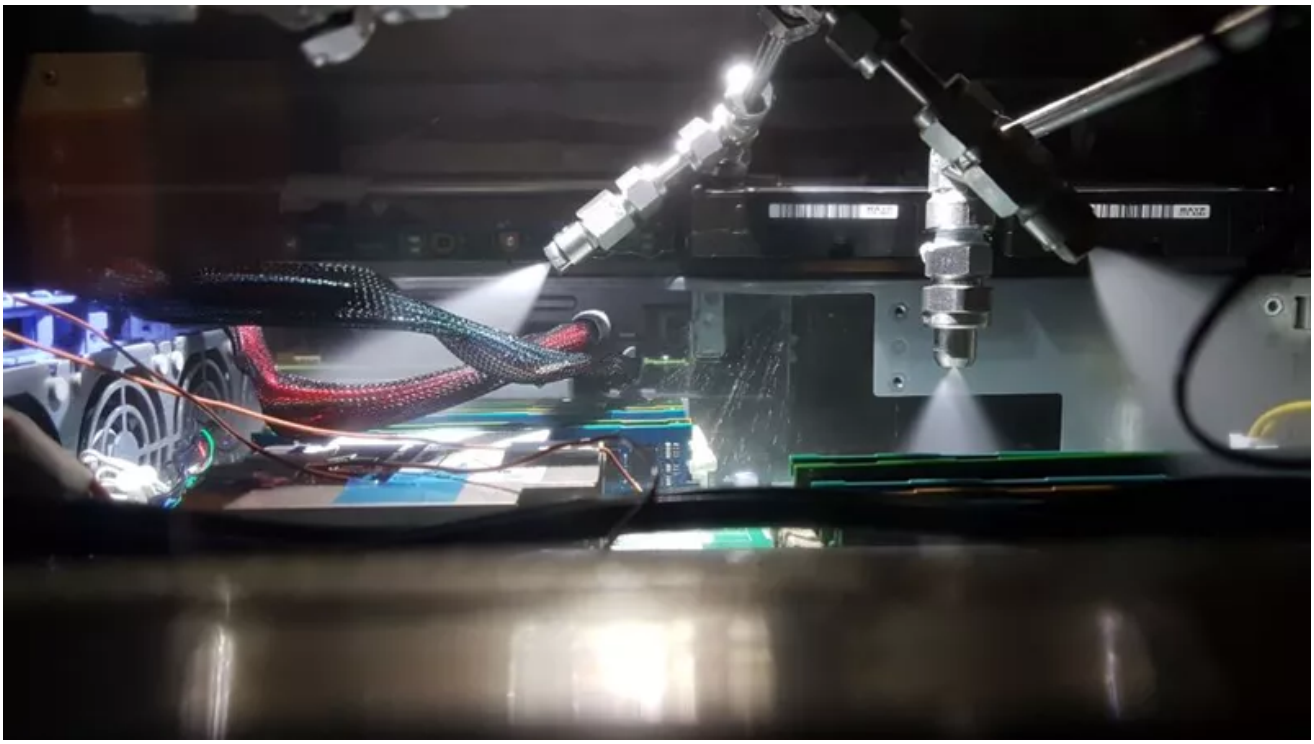
Costs associated with running data centres could be reduced by spraying non-conductive fluids onto CPUs, scientists at Nanyang Technological University, Singapore have found.



Close up of the spray cooling over the server racks within the prototype - *NTU Singapore*

The more sustainable method for cooling down servers in data centres could reduce energy costs and carbon footprint by up to 26 per cent, they claim.

Data centres in Singapore account for seven per cent of the nation's total electricity consumption and the demand for cloud computing is increasing.

The hottest component in a data centre server is the central processing unit (CPU), which requires a dedicated air-cooled heatsink.
When servers are stacked together in a rack vertically, they produce a substantial amount of heat, so cold air is drawn in to cool the server and hot air is then expelled to the surroundings.

The new method developed by NTU scientists uses a spray of non-conductive fluids to cool the CPU directly without a heatsink, utilising a combination of highly efficient heat removal mechanisms such as evaporation and boiling.

The gases and excess fluids are then collected in an enclosed system, condensed into liquid at tropical ambient temperatures (around 30oC) and recirculated back into the system for reuse.

According to NTU, spray cooling has the potential to carry away more heat than air cooling, which will allow for CPUs to run faster.
Based on the power consumed by the servers in a rack (rack density), the resulting waste heat generated is estimated to be around 7kW per cubic metre in conventional air-cooled racks. In comparison, the spray-cooling prototype is capable of handling rack densities as high as 23kW per cubic metre.

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In a statement, project leader, Associate Professor Wong Teck Neng from NTU's School of Mechanical and Aerospace Engineering, said the main benefits of their new method are its high energy efficiency and targeted approach.

Assoc Prof Wong explained that their targeted approach is a smarter approach, particularly in tropical environments where high humidity and heat can put a significant strain on traditional air-cooling systems.

A conventional data centre must be cooled down to about 18oC, which accounts for about 40 per cent of its total energy usage.

In contrast, using spray cooling, CPUs can maintain their optimal temperature at about 55oC without the need for energy-intensive air-conditioning units.

Power usage effectiveness (PUE) – the ratio of the total amount of power used by the data centre versus the actual power delivered to the servers – of the new prototype can go as low as 1.08 compared to traditional air-cooled data centres which are usually 1.8 PUE.

Studies by the team also showed that based on a data centre IT load of 1MW, their spray-cooled system could save up to 1550 tons of CO2 emission annually compared to conventional air-cooling systems. Energy-efficient operation of a spray-cooled data centre can also lead to 26 per cent savings in annual energy costs.

The prototype system consists of an enclosed spray-cooled server rack capable of operating near atmospheric pressure, a water pump, sprays with multiple nozzles over each CPU, a collection system to collect the vapourised liquid, and an energy-efficient room-temperature condenser to convert the gases back into liquid again. Unlike conventional air-conditioning systems, no chiller system is required.

It was developed by a multi-disciplinary team, which involved former Assoc Prof Toh Kok Chuan, Asst Prof Ho Jin Yao from NTU's School of Mechanical and Aerospace Engineering, and research fellows Ranjith Kandasamy and Liu Pengfei.

The NTU team took three years to design, build, test and commission their working prototype. Patents for the technology have been filed through NTUitive, NTU's innovation and enterprise company.

Prof Wong and his team will now seek to work with industry partners to develop a larger pilot plant.

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