M.Sc. Assignment : Development of heat pipe based cooling solutions for data centers

NovoServe is a Dutch Infrastructure-as-a-service company that operates over 5000 servers in several datacenters. Both running and cooling these servers consumes a significant amount of energy. To improve our environmental footprint we are committed to reduce our energy usage and strive to go beyond what is common in our business.

A server consumes a lot of electrical energy and turns nearly all of that into heat. This heat has to be removed from the server to prevent damage and increase its lifetime. Most servers today are air-cooled: cold air enters the server chassis from the front, moves over the hot components while absorbing their heat and leaves the server at the back. The hot air is then cooled elsewhere in the datacenter and recirculated as cold air. Servers are commonly packed vertically in cabinets of 30 to 40 servers called 'racks' that contain the required infrastructure such as network and power connections and could also be modified to play a role in the server cooling.

Some components within a server produce nearly all the heat (e.g. the CPUs), and cooling them using air has a couple of disadvantages. First of all, air has a relatively low heat capacity, so lots of it has to be moved across these components to remove enough heat energy. And secondly, the hot air leaving the server is still too cold to easily recover the waste heat for other purposes.

To improve both the energy efficiency of the cooling process and the possibilities for waste heat reuse, NovoServe would like to investigate different ways to cool these 'hot spot' components within a server. Liquid cooling could be an option, but we regularly have to remove a server from a rack to make changes to its hardware and managing fluid connections complicates the design and maintenance processes.

Within laptop computers, heat pipes are commonly used to move heat from components such as the CPU to another location where cooling can be more easily implemented (e.g. where there is enough space for a fan). Similar to this concept, we would like to investigate whether a heat pipe could be used within a server to move the heat from the central CPUs to the back of the server chassis where it can more easily be removed. As CPUs typically run quite hot, this should also provide waste heat of a higher temperature that could be reused.

Some example research questions that could be investigated in this MSc project:

- What is the best type of heat pipe for data center cooling?
- How can heat pipes be designed to efficiently transfer enough heat from CPUs to the back of the server chassis?
- How can a heat pipe in a server be connected to a rack-based cooling system (e.g. a liquid cooling loop) combining easy installation and removal of the server with a sufficiently large heat exchange capacity? For example: could a simple contact surface be used, and if so, what materials would be best?
- Would it be possible to install such a system in an ordinary air-cooled server by reusing some of the space traditionally used for the air flow while still leaving enough air cooling capacity for the remaining components? Or will a custom design usually be required?

Work on this project will in part take place at the office of NovoServe in Enschede, to facilitate interaction with the rest of the NovoServe team.

Your background: We are looking for excellent master students with a Mechanical Engineering background.

Contact: Dr. Davoud Jafari (davoud.jafari@utwente.nl)

Dr. A.K. Singh (a.k.singh@utwente.nl)