i-STUTE

Interdisciplinary centre for Storage, Transformation and Upgrading of Thermal Energy

Upgrading of thermal energy in data centres

Gareth Davies and Graeme Maidment, London South Bank University

How much energy do data centres use and what is it used for?

Data centres consume 2-3% of the UK's energy and produce between 2.8 and 4.2 million tonnes of CO_2e emissions. This is projected to increase by 400% by 2020.

Data centres house IT servers, which process and store information transmitted via the internet. Electricity is used by the servers to perform IT work. This is converted to heat, which needs to be removed by cooling to keep the microprocessors below 85°C.

Traditional cooling involves directing a cold air stream through the server racks via computer room air conditioning (CRAC) units (see Figure 1). Typically 50% of data centre energy is used for cooling.

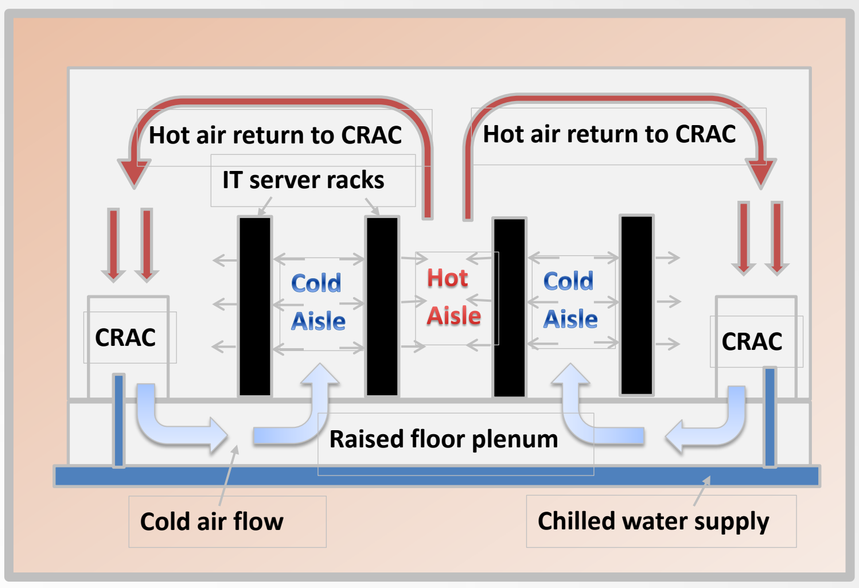

Fig 1: Conventional air cooling of data centre

Energy saving options for data centre cooling

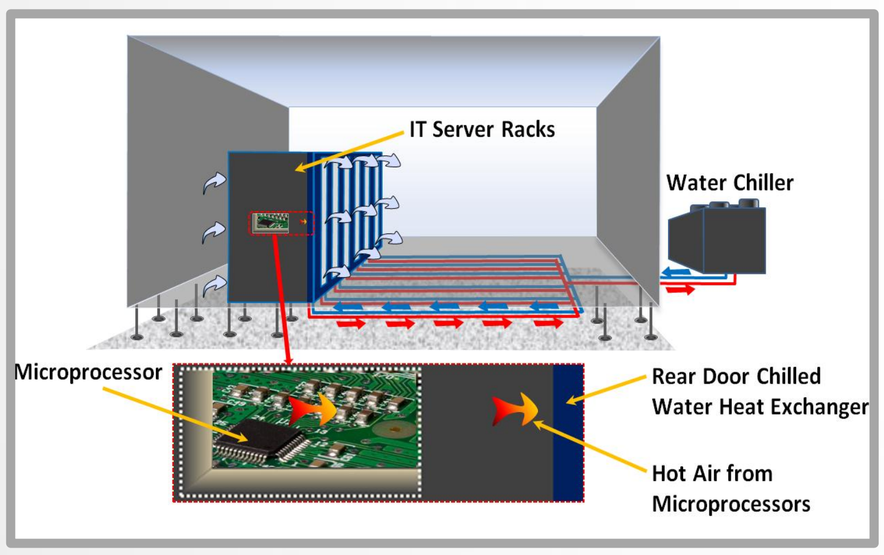

Fig 2: Rear door chilled water heat exchanger

A wide range of cooling technologies with potential for energy/carbon saving are presented in the literature. These include:

1. Air based methods e.g. free, evaporative, adiabatic cooling & economisers.
2. Liquid based methods e.g. single phase water cooling – direct on-chip and rack cooling (Figure 2); and two-phase liquid cooling – spray cooling, on-chip liquid cooling and total liquid immersion.

Such methods have potential but have not been evaluated. In addition, integration of heat recovery with most cooling methods is not well developed. This initial study evaluates a range of solutions for minimisation of energy input, while maximising heat recovery opportunities; and identifies new opportunities for investigation.

Initial results and next steps

The property exergy, which indicates the quality (i.e. usability) of the energy recovered from a process has been used to evaluate different cooling options. The results will be used to develop a roadmap for the data centre industry for the adoption of new cooling methods with low energy demand and potential for heat re-use. Some of the initial results are shown in Table 1.

Table 1 Exergetic evaluation of cooling approaches

Cooling medium	Cooling method	Chip temperature °C	% Exergy recovered
Air	Conventional	60	1.1
Water	On-chip, pumped	60	5.0
		85	8.4
Refrigerant	On-chip, pumped	85	8.7
	On-chip, vapour compression	85	14.8

Future work will focus on detailed investigations of selected low energy cooling technologies e.g. on-chip cooling using porous media evaporators, pumped 2-phase coolant and vapour compression cycles, and their integration with heat recovery systems.

Potential applications for the energy recovered from data centres include domestic and industrial space and water heating, district heating, desalination, absorption refrigeration, organic Rankine cycle (ORC) and biomass processing.

Contact: Gareth Davies - daviesg@lsbu.ac.uk - 0207 8157962