Cooling in the data centre - an end-user view

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Almost all of the energy that goes into a piece of electronic equipment is converted into heat. In a small data centre that's a lot of heat and in a big data centre, it's an awful lot of heat. Somehow it has to be disposed of; otherwise the equipment will stop working.

The history of electronic design has led to air cooling as the usual way of removing this heat. The heat is conducted from the semiconductor or other source onto a finned heatsink and cool air is blown over it. The heated air is then cooled and re-circulated. Mostly, this is a bad idea – air is a poor conductor of heat, large volumes of air are needed and the air carries vaporised water which inconveniently turns to liquid water when cooled. The air flow also transfers dirt and other contaminants on to the heatsinks, reducing their efficiency over time. It is however a well-established technology which is cheap to make, quick and relatively foolproof to install and works well for low volumes of heat.

Does cooling efficiency matter?

Every kW of power used for cooling is a wasted kW which could be used to power electronic equipment. Where power availability is limited, every kW used for cooling restricts the size of the data centre or colocation business, reducing efficiency and creating needless carbon emissions. The industry is aware of the issue so it is no surprise that there is a worldwide push to make electronic equipment cooling more efficient.

However, many servers are not in major data centres but in organisations' "server rooms" or "comms rooms". Most are highly inefficient and efficiency is not necessarily regarded as important inside an organisation as it is not a visible metric. If a worthwhile proportion of servers could be implemented into efficient, professionally-run colocation data centres, then they could provide more efficiency gains and carbon reduction than any amount of tweaking.

Options for improvement

Most smaller comms rooms or data centres use direct expansion (DX) cooling, delivering cool air either from above the racks into a cold aisle or from under the floor through evaporators, where a liquid refrigerant absorbs heat as it expands into a gas. In previous times, such standard commercial units were designed to be sold for low capital cost as that was what the market wanted. Today, the market is much more energy conscious, and modern units will achieve COP figures around 3.0.

We have measured older units, with worn bearings, worn seals, and fins that have been many times through pressure cleaning, at COPs of under 1.5. That means that just replacing an old unit with a new one of the same specification can give a doubling in efficiency.

Fresh air cooling produces the best results with cold air from the outside filtered and mixed with warm recirculated air from the servers and fed to the data centre floor at a constant temperature. A cooling system is necessary for the summer when the outside air temperature is higher than the setpoint temperature for the server inlets. Attention is also necessary to control humidity, particularly when it rains. The biggest resistance to this comes from colocation customers who do not like the idea of fresh air being fed to their critical equipment. External acoustics also have to be carefully considered, since relatively large volumes of air must be moved and large fans starting and stopping in the middle of the night can be disruptive to neighbouring properties. But if properly designed and explained to customers, fresh-air cooling offers scope for big gains in cooling efficiency.

Evaporative cooling, the old desert cooling idea of a wet blanket being hung up with a fan pointed at it, should also be considered. Efficiencies can be considerably high, however it reduces as the outside air becomes more humid, and care needs to be taken with algae growth and prevention of Legionnaire's Disease.

The simplest and most effective way to improve efficiency in a colocation data centre is to put blanking plates into the racks to stop cold air bypassing the servers, mixing with the hot air to reduce the temperature into the cooling unit and reducing efficiency. But how often do you see racks with no blanking plates? And when blanking plates are put in, if the organisational disciplines are not there, then they will gradually get removed over time and not returned. Plus, how often do you see an installation with the server outlets blowing cold air into the hot aisle? There shouldn't be any, but there are. Managing the operational people issues is at least as important as the technology.

Energy used in cooling is energy wasted, and a lot of energy is wasted in cooling. Fortunately, there are many marketing, technology and people management initiatives that can reduce waste by substantial amounts.