Air Cooling

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In data centers, controlling the temperature is extremely important. Essentially, all electric power consumed by the IT equipment is converted to heat. In a data center with hundreds, or maybe even thousands of machines, all this heat can be a problem if it is not managed properly. If the equipment is not cooled properly, it raises the chances of equipment failure, which in turn reduces the reliability and performance of the services the data center provides. This requires a data center to have specifically designed air conditioning system which has been optimized to regulate the temperature and humidity of a server room. Most data centers use a traditional air cooling system with air conditioners artificially controlling temperature, but the method of using unaltered outside air for cooling has been used in at least one data center.

figure 1

In order to help optimize server room cooling, data center server rooms are built with a raised floor. This is similar in function to hanging ceiling tiles. The raised floor is used to create a space where network and power cables can be placed, in addition to cooling infrastructure. Placing these cables under the floor has the advantage of keeping them safe from getting accidentally unplugged or hit when people have to move through the server room, in addition to keeping the room looking less congested [1]. Cooling vents are placed under the floor to optimize the server room cooling. Cold air comes from under the floor, while hot air is extracted from vents in the ceiling. Since hot air rises and cold air sinks, this set up ensures that the extraction vents in the ceiling only get the warmest air in the room.

To further optimize the cooling system, the aisles between rows of servers are separated into alternating hot aisles and cold aisles. The cold air vents in the floor are only in cold aisles, and the heat extraction vents in the ceiling are only above the hot aisles. The rows of servers themselves are specially arranged to take advantage of this. Each server is oriented so that its air intake fan is pointed to the cool aisle and its air output is pointed to the hot aisle.
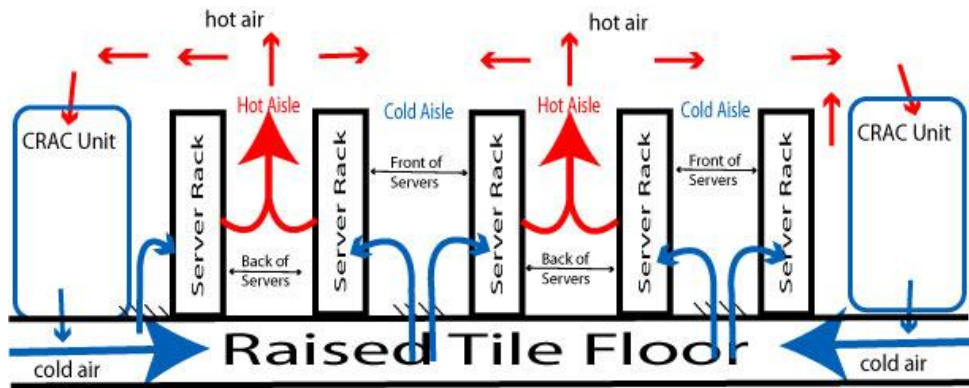
figure 2

So, as the server's fan blows in air to keep its components cool, it is taking in cold air from the cold aisle and blows out the hot air into the hot aisle. This ensures that energy isn't wasted in cooling air only to have it mix with warm air from the servers, or that the servers aren't trying to cool themselves with warm air.

Currently, data center design has the cold air coming from an air conditioner unit, though this is now not the only source of cool air for the cold aisles. At Facebook's Oregon data center, they do not artificially cool the air. Instead they just take air from outside and blow it into the server room without changing its temperature. This method of using outside air can significantly reduce the power consumption of a data center, since cooling air is a very energy intensive process [2].

With both traditional air cooling and outside air cooling, the humidity of the air going into the server room needs to be controlled. For the most part humidity does not affect performance of the servers, but it does affect the longevity of the equipment. Too little humidity and there's the risk of static electricity damaging components. Too much humidity and water can condense inside the servers and short out components. So, data centers typically keep humidity within 30%-60% to avoid these issues [3]. Humid air does have a higher specific heat, so it is able to hold more heat, which in turn makes it more effective at cooling. However, the higher specific heat also makes the air harder to cool. So, the extra heat capacity is canceled out by the extra cost to cool the air.

Traditional air cooling is likely to dominate data centers for some time, since the infrastructure is already there and re-designing existing data centers would be an expensive endeavor. As demand for data center services increases however, other more efficient methods will become more and more appealing. New data centers can be designed with things like outside air cooling in mind, and pre-existing data centers might see re-designing as cheaper than their current methods.

References

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Figure 1 from http://www.raisedfloorservices.com/about_us.html

Figure 2 from http://datacenter.cit.nih.gov/interface/interface240/energy_efficiency.html