Green Computing – Energy Efficient Cooling

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Abstract:

Green computing is the practice of using computing resources efficiently. The goals are to reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote recyclability or biodegradability of defunct products and factory waste. Data center servers use 50 times the energy per square foot as an office. To keep servers at the right temperature, companies mainly rely on air-conditioning equipments. The more powerful the machine, the more cool air needed to keep it from overheating. Cooling is an extremely important process in modern data centers. Cooling systems of server rooms ensure appropriate operation conditions to IT systems, such as servers and data storage, but, on the other side, they consume a lot of energy. Cooling equipment needs to be specifically designed for computers and have adequate temperature and humidity controls. If the humidity level is not controlled you either end up with damaged equipment due to static electricity or servers dripping with water due to condensation. Also, it can cost about 50 percent more in operating costs if you try to make do with a comfort cooler.

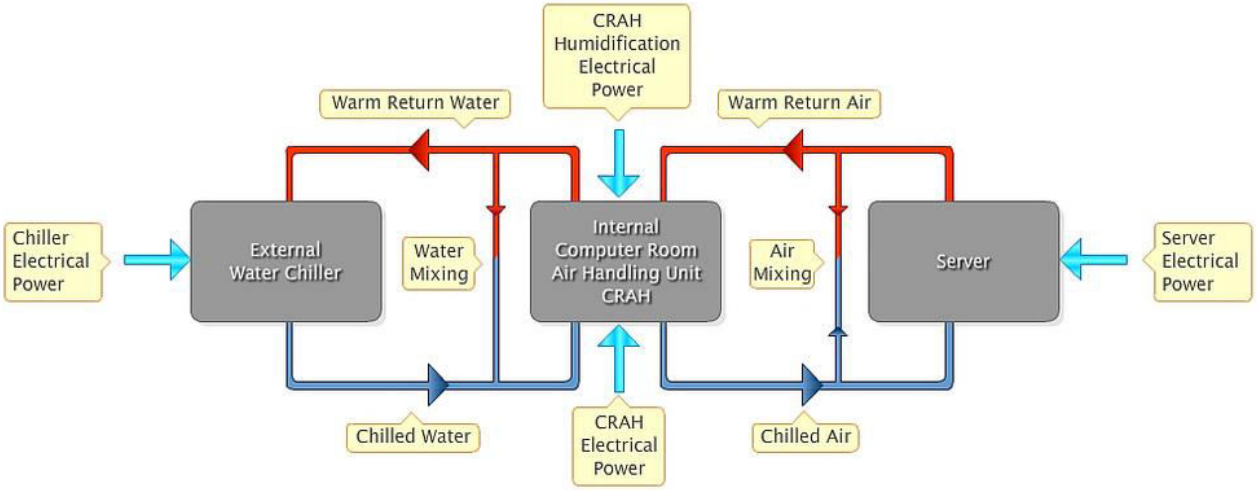
Keyword: Traditional cooling system, server room making humming, portable air conditioner, APV evaporation air cooler, hot and cold aisle containment.

I.Introduction

Cooling is key for green computing. Arranging so that the cold air comes in the front and is expelled out the back; keeping the doors to the room closed; ensuring that the flow of cold air makes it to the equipment; Without cooling , IBM data centers in north Italy would be as hot as pizza ovens in the company cafeteria. But how can you keep the servers from burning and not bankrupt your company in the process? With a technology called free cooling.Opening a window to let the heat out of a small space that contains a few servers is wrong since you have no control over the humidity aid. Tight control of temperature is also a vital factor in equipment uptime. It isn't common knowledge, but temperature changes affects equipment reliability. For every 18 degrees F above 70 degrees, electronics reliability is reduced by 50 percent.

The specific tips relating to equipment rooms under 500 square feet. Number one on the list is to avoid using AC systems designed for humans – known as comfort AC. This, he said, is probably the number one failing in small business cooling – next to not having any cooling at all.Installing precision cooling gear that comes in various configurations depending on the room needs. You can buy rack enclosures, for example, where the cooling is built into the bottom of the rack. You then slide your servers into the enclosure to keep them cool. Alternatively, you can buy wall-mount, ceiling-mount or standalone cooling modules that are more than adequate for small spaces.

"Eighty percent of failures due to heat will be found in the top third of the rack," said Spengler. He



recommends the use of blanking panels on the front of the rack to cover the spots where servers are missing. Without this, cold air runs through to the back of the rack and into the hot air at the back, rather than making its way up to the top of the rack. In situations where there is a whole rack sitting empty, you can put blocker panels at the front to prevent any cold air getting in.The next point to avoid, if possible, is mixing people with a lot of computers. That adds heat to the space and puts a lot of strain on the servers. So place your servers and other equipment in a closet or small room in order to create a tightly controlled environment. For companies with several server racks, it is vital to ensure the cold air actually gets to where it is needed and doesn't mix with the hot air being shoved out the back of the server. You can have a situation, for example, where you are pumping enough cold air into the room, but it isn't getting to the top of the racks.

Growing Threat

International Data Corp. (IDC) has been tracking data-center power and cooling issues for years via an annual survey. And small businesses are suddenly in the spotlight.

"Smaller installations such as server closets and rooms register highest in terms of cooling issues," said Jed Scaramella,

an analyst at IDC. "There are some very easy solutions customers can adopt such as blanking panels between racks to improve air flow."

He recommends that small businesses call in outside help to figure out their cooling needs as there are too many ways to get it wrong. And the results can be disastrous. "Consider the expertise of a third party service provider," said Scaramella. "With space and thermal issues, it is somewhat of a science that goes into running a computer room."

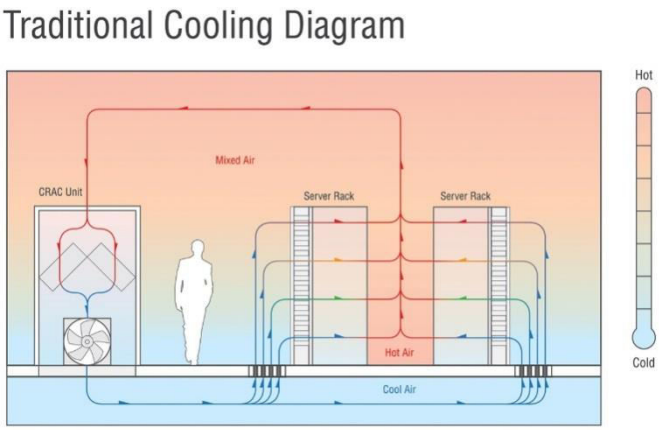
BASICS OF server COOLING

Cooling is a critical part of a data center's infrastructure, and fortunately (or unfortunately), a number of approaches are available to maintain the necessary temperatures to keep your facility's electronic equipment running. Although a complete discussion of all the design concepts associated with cooling infrastructure could easily constitute a large.

Does your server room really need air conditioning ?

Your server room is the heart of your business so if anything happens to it, you're at risk of losing all of your precious data. One of the biggest risks to your server room is excess heat, which can cause damage to the hardware, random reboots and overall poor performance. As every server is working 24 hours a day and constantly producing heat as it does so, it is a continual balancing act to keep your servers at an optimum temperature and prevent over-heating. Although some people recommend not allowing your server room to be warmer than 23 degrees Celsius, there are several companies who have reported temperatures of around 35 degrees Celsius without any issues. One example of this is Facebook who have done away with the traditional method of air conditioning for their data centres in favour of alternative methods.

Although air conditioning has become a lot more energy and cost efficient over the past decade, it is still very costly to both your business and to the environment. The units contain ammonia, Freon and chlorofluorohydrocarbons (CFCs) which are harmful to people and the ozone layer. Switching from air conditioning units to simply fanning in fresh, outside air can reduce the cost of keeping your server room cool by around 85% which means a huge cut to your



energy costs. They can be used throughout the night so there is no longer a need to leave air conditioners running 24/7 just because your servers are.

One of the methods:

used by Facebook to prevent their servers from over-heating whilst doing away with the air conditioners is

to rearrange the equipment so that it almost keeps itself cool and helps to aid air flow. Similarly, these principles can be utilised throughout your office so you can decrease your energy bills even more and shrink your carbon footprint. An Energy Consultant can come up with innovative changes that can utilise strategies like these and save you money and energy both in your server room and throughout your office.

As well as the environmental impact of air conditioning, it can cause cold and flu symptoms and the sudden change in temperature can lower people's immune symptoms, all of which can add up to a lot of extra sick days being taken. You will be surprised at how much money you will save withoutsacrificing comfort when you explore alternative cooling andventilation options.Thermal Considerations for Data Center:

Hot and Cold aisle:

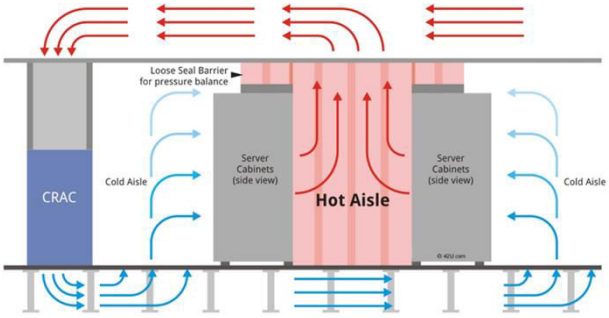
As most of the IT equipments breathe from front to rear the hot/ cold aisle aligns the cabinets in rows with the server exhausts of each row facing one another, becoming the hot aisle. Hot aisle containment immediately captures server exhaust air and restricts its entry to the rest of the data center. The exhaust air's destination depends on the containment configuration. Energy intensive IT equipment need good isolation of "cold" inlet and "hot" discharge. Computer room air conditioner airflow can be reduced if no mixing occurs. Overall temperature can be raised in the data center if air is delivered to equipment without mixing. Coils and chillers are more efficient with higher temperature differences

Hot aisle:

The goal of hot aisle containment is to capture the hot exhaust from IT equipment and direct it to the CRAC as quickly as possible. Mainly two types of systems achieve containment: the "room" or the "chimney". Similar to cold aisle containment, the "room" method seeks to separate the hot aisle with barriers made from curtains, or metal enclosures. The "chimney" method uses special server racks with chimneys to direct hot exhaust into the return air system or overhead plenum. Hot aisle containment is an excellent option for new data center builds and those with existing hot air return ducts or over-ceiling plenum space.

Cold aisle:

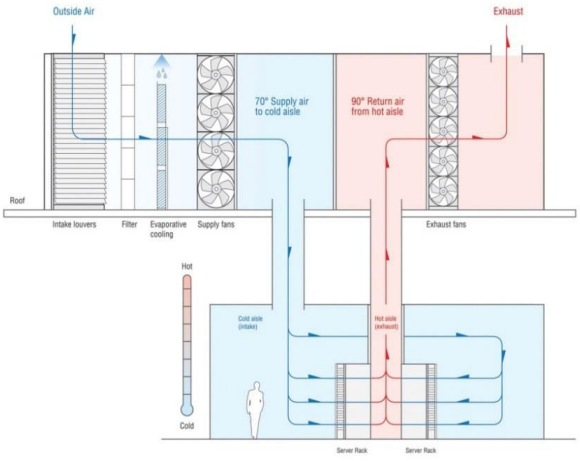
As the name implies, cold aisle containment attempts to isolate the cold air in a "room" of its own. By using containment curtains, metal, or other similar barrier, the cooling air is concentrated at the equipment



intake. The cold air must pass through the server racks, cooling the equipment, before entering the rest of the room. Clearly, the focus of cold aisle containment is to cool the IT equipment, not the whole room, with targeted cooling at the equipment inlet. Cold Aisle containment can be a cost effective approach for older data centers with open-room hot air return schemes.

Implement Cooling Best Practices

The nature of data center temperature management underwent a dramatic evolution when American



Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) adopted new operating temperature guidelines. A range of higher intake temperatures at the IT devices has enabled substantial increases in computer room temperatures and the ability to cool using a range of 'free cooling' options. However, recent Uptime Institute research

has demonstrated that the practices used in computer rooms to manage basic airflow and the actual adoption of increased temperatures have not kept pace with the early adopters or even the established best practices. This gap means that many site operations teams are not only missing an opportunity to reduce energy consumption but also to demonstrate to executive management that the site operations team is keeping up with the industry's best practices.

Server Cooling:

ITE generates heat as the electronic components within the ITE use electricity. It's Newtonian physics: the energy in the incoming electricity is conserved. When we say a server uses electricity, we mean the server's components are effectively changing the state of the energy from electricity to heat.

Heat transfers from a solid (the electrical component) to a fluid (typically air) within the server, often via another solid (heat sinks within the server). ITE fans draw air across the internal components, facilitating this heat transfer.

Some sytems make use of liquids to absorb and carry heat from ITE. In general, liquids perform this function more efficiently than air. I have seen three such sytems:

• Liquid contact with a heat sink. A liquid flows through a server and makes contact with a heat sink inside the equipment, absorbing heat and removing it from the ITE.

• Immersion cooling. ITE components are immersed in a non-conductive liquid. The liquid absorbs the heat and transfers it away from the components.

• Dielectric fluid with state change. ITE components are sprayed with a non-conductive liquid. The liquid changes state and takes heat away to another heat exchanger, where the fluid rejects the heat and changes state back into a liquid.

In this article, I focus on systems associated with air-cooled ITE, as that is by far the most common method used in the industry.

Close-Coupled Cooling

There are other methods of removing heat from white spaces, including in-row and in-cabinet solutions. For example, rear-door heat exchangers accept heat from servers and remove it from a data center via a liquid.

In-row cooling devices are placed near the servers, typically as a piece of equipment placed in a row of ITE cabinets. There are also systems that are located above the server cabinets.

These close-coupled cooling systems reduce the fan energy required to move air. These types of systems do not strike me as being optimal for Sabey's business model. I believe such a system would likely be more expensive and less flexible than Hot Aisle containment layouts for accommodating unknown future customer requirements, which is important for Sabey'soperation. Close-coupled cooling solutions can have good applications, such as increasing density in legacy data centers.

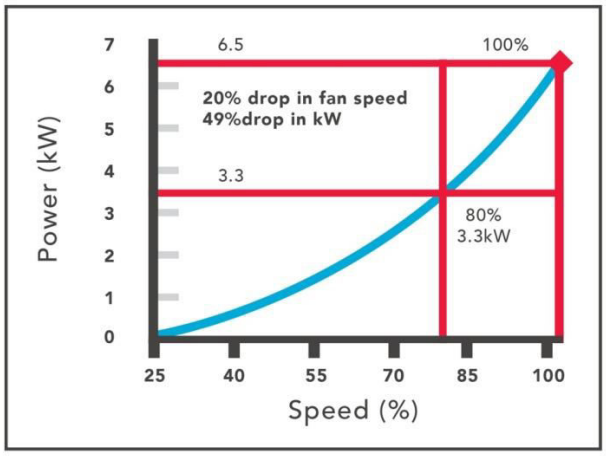
Additional Advanced Energy-Efficient Actions

There are additional measures, which can be taken in order to further increase the overall efficiency of the cooling systems supporting the data center, including implementing variable speed/frequency fan drives, utilizing supply air control and increasing the chilled-water temperature where chilled-water systems are utilized. These measures, while requiring increased engineering study and operational awareness prior to implementation, can continue to lower the amount of electricity required for the cooling plant, while simultaneously maintaining a more consistent ambient environment in the data center.

Implementing supply air control

Supply air control typically requires the addition of supply air temperature sensors, as legacy air conditioners are typically not equipped with these devices. The supply air sensors will be the modulation control point for the units to ensure a consistent supply air temperature for the data center. Most legacy data centers are still utilizing standard return air control methodologies. However, data centers with supply air control methods are realizing two important benefits. First, in conjunction with good airflow management practices, supply air control guarantees a consistent inlet air temperature through all cold aisles in the data center. Second, it reduces the importance of the ΔT of the air handlers. Data centers utilizing return air control are forced to

use an artificially low return air set point in order to guarantee that the cold aisle temperatures do not exceed their normal design temperature. But, this is not an issue for data centers utilizing supply air control.



The power consumption of a fan is a function of the cube of the fan speed

Implementing variable speed fan drives Since the power consumption of a fan is a function of the cube of the fan speed, operating additional variable speed cooling units or fans will further reduce power consumption (see Figure 2). This can be accomplished by retrofitting any constant speed cooling fans to variable speed or by replacing legacy units with new units with built in variable speed capability. Implementing variable speed fan drives will require close interaction with the OEM of the cooling units, and possibly, other assistance, depending on the qualifications of the facility staff.

Increasing Chilled Water Temperature A chilled water system is one of the largest single facility power consumers in the data center. Raising the air handler temperature set point provides the opportunity to increase the temperature of the chilled water and further reduce energy consumption. Typical legacy data centers have chilled water set points between 42-45°F (6-7°C). Facilities that have gone through optimization of their cooling systems have successfully raised their chilled water temperatures to 50°F (10°C) or higher.

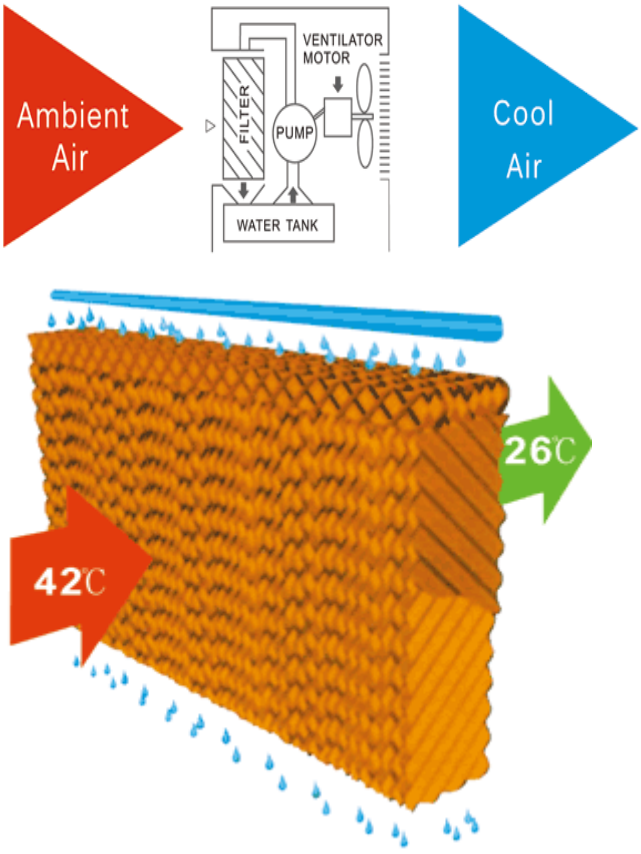
18APV evaporative air cooler

Nature's most efficient means of cooling is through the evaporation of water. Evaporative cooling works on the principle of heat absorption by moisture evaporation. It also happens on human skin, the body sweat to cool temperature down.

Standard unit evaporative air cooler18000cmh airflow, suitable for 100~150sqmDown discharge type for roof, window and wall installationLuxury plastic cabinet, best quality, 100% virgin materialTempterature and humidity control functionMitsubish Inverter control corePatented pad clean functionPatent exhaust function

Working principle

Nature's most efficient means of cooling is through the evaporation of water. Evaporative cooling works on the principle of heat absorption by moisture evaporation. It also happens on human skin, the body sweat to cool temperature down.



JHCOOL evaporative cooler produces effective cooling by combining the natural process water evaporation with a simple, reliable air moving system. Fresh outside air is filtered through the

saturated evaporative media, cooled by evaporation, and circulated by a blower.

Advantages of evaporative air coolinglow carbon green product, environmentally friendly, no cfc's , no damage to the ozone layer. Super energy-saving, only cost 1/10 electricity than air con. Less than ½ the price of air conditioning.Vent cooling no air re-circulation.Four tricks of cooling server:Trick For Cooling A Server Room: Install a Portable Air Conditioner

Eg :https://youtu.be/HxSLbpAwibg

Installing a portable air conditioner into your server room can be a good way to keep it cool. But if you can't afford it or don't see the value in dropping a few hundred to a few thousand dollars, you can always make your own air conditioner:

Here are a few tips regarding this DIY air conditioner: When filling the air conditioner with ice and water, the room might get humid. Keep an eye on the humidity levels. If you don't monitor and control the humidity, you could create static electricity problems or cause condensation on the equipment. To limit humidity, use really cold bottles of water instead of tons of ice/water.

This means a bit more manual work, but it should work well.This DIY air conditioner is cheap and easy to make. It will help you cool down your server room or data center quickly. There are other versions out there as well, so look for other videos on YouTube if you don't like that one.Trick For Cooling A Server Room: Ceiling Hacks:

If I remember high school science correctly, heat rises. Try removing a few ceiling tiles, which will lift the heat beyond the top of your server racks.

If you don't have ceiling tiles or you determine this is a fire code violation where you work, add a vent above your doorway.

Just make sure that if your server room is cooler than the room outside the door to close the vent to keep the cool air in.

Trick for Cooling A Server Room: Use Blanking Panels

Blanking panels are installed where you don't have servers in your rack. Without blanking panels, cooler air will travel into the space where the server isn't rather than to the top of your server rack.

The top of your server rack will experience problems first (remember, heat rises!), so by placing the blanking panels in the rack, the cool air will travel up to the top of the rack, rather than into the rack and behind it — which is where all the hot air resides.

Trick for Server Room Cooling: Move Servers to the Cloud:

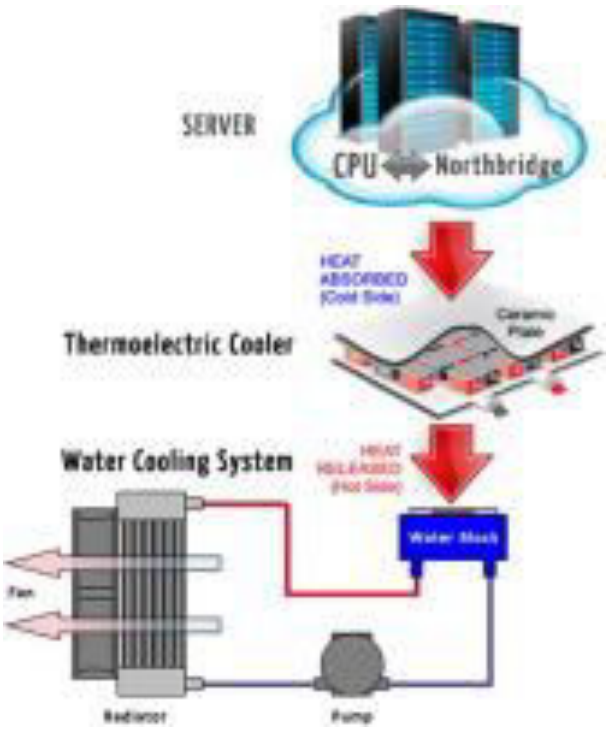
Less servers means less power consumption, and therefore less heat. A cloud file server can go a long way to aiding with your server room cooling. Worried about the lack of a file server in your office? Many startups go with a LAN-less environment, and use an all-in-one file management solution like SmartFile for global access to files in the cloud.

Cooling efficiency of thermoelectric modules on server cpu and northbridge

Computer systems are required to process data more rapidly than ever, due to recent software and internet technology developments. The server computers work continuously and provide services to many clients simultaneously, which results in greater heat production and high temperature that must be managed in order to avoid malfunction and failure of critical hardware. In this study, three cooling systems were used comparatively to examine the temperature

and performance of the CPU and motherboard. The temperature characteristics and performance of the CPU were tested with a heat sink, water cooling system, and thermoelectric cooler. According to the test results, the thermoelectric cooling system has better cooling performance than the other two systems under continuous operating conditions. Additionally, the performance rating of the CPU was the best with a thermoelectric cooler under varying workloads.

Graphical abstract



5 WAYS TO MAKE SERVER COOL

1. Use low-heat lighting.

If a server room needs anything, it needs proper lighting. Server rooms with poor or reduced lighting create more opportunity for human error. But with well-lit data centers, employees can complete each task with accuracy. It's always a good idea to invest in LED or low-heat lighting for your server room to promote the ideal temperature.

2. Let hot air escape the room.

Server rooms are often too small for the equipment they hold. This lack of usable space contributes to an overall lack of ventilation. Make sure to pick a room that will provide the space you need for access, cooling, and ventilation.

If you currently have a smaller than ideal server room, provide ways to maintain proper air flow. This includes making use of a functioning ventilation system. For low security server rooms, you may even remove a ceiling tile to let the heat rise out entirely. Another option would be to prop the door open from time to time.

3. Inspect and adjust your HVAC system.

By checking your HVAC system and its filters, you'll boost productivity across the board—for servers and for your employees. Do semi-annual checks to maintain proper HVAC function and to avoid any potential problems.

Many companies house their systems in a building with third-party management. If this is the case, communicate regularly with your facility manager to ensure proper heating and cooling.

4. Use fans to cool equipment.

Fans may seem too small-scale to make an impact, but unlike portable or dedicated air conditioners, fans offer an affordable solution. Most server rooms produce heat in the same places: behind the equipment. Although a good HVAC system will help keep the room cool, direct cooling works even better. Placing small but powerful fans in the high-heat areas will maintain target temperature for expensive hardware.

5. Organize server racks.

Server racks save a lot of headache when it comes to server access. However, you can take this organization principle one step further by planning the layout of each row. Once you arrange your servers with neatness and precision, you'll achieve better access and lower heat levels.

Keeping cables neat and organized prevents many common overheating problems. Help keep your hardware cool with properly organized server racks.Fjord-Cooled Data Center Gets Anchor Tenant

The tunnels linking data halls in the Green Mountain Data Center in Norway, which will use cool water from a nearby fjord to support its cooling system.

The Green Mountain Data Centre in Norway, which taps frigid fjord water in its cooling system, has signed a major Nordic IT company as its anchor tenant, the company said this week. Green Mountain is a 21,000 square meter (226,000 square foot) nestled along the shores of the island of Rennesoy, inside concrete buildings within caves carved out of the mountain. Racks of servers will now fill underground halls that once stored ammunition for NATO.

Too Hot for Humans, But Google Servers Keep Humming

The Google data center in Belgium, which features no chillers and routes traffic to other facilities during hot spells. (Photo from Google)Raising the temperature in server racks can make a data center more efficient. But what happens if the room gets too hot for people?If you're Google, the servers keep humming along while the humans retreat to climate-controlled sections of the building. That's what's been happening at Google's data center in Belgium, which was the company's first facility to rely entirely upon fresh air for cooling, instead of energy-hungry chillers. That approach has helped the facility become Google's most efficient data center.

The Google data center in Belgium, which features no chillers and routes traffic to other facilities during hot spells. Raising the temperature in server racks can make a data center more efficient.

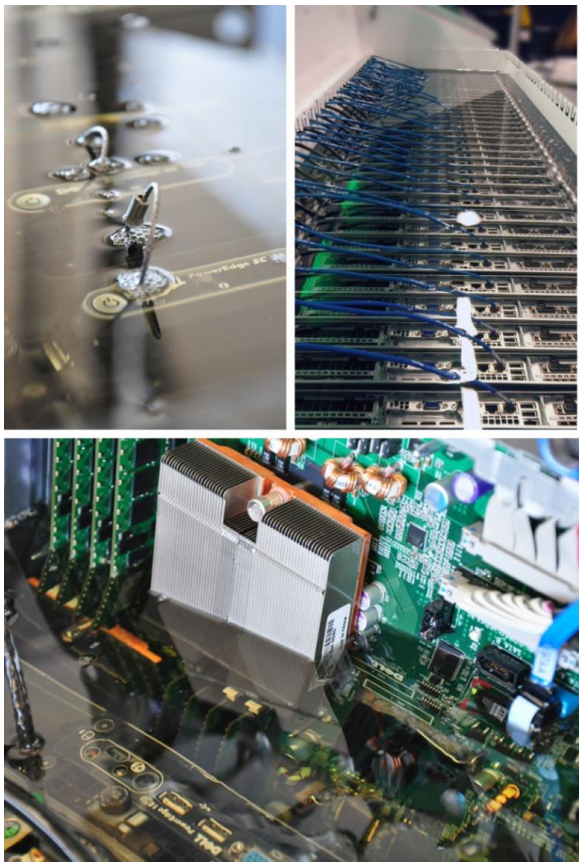
Fluid Cooling Systems

The fundamental difference of fluid cooling and Freon cooling is the fact that fluid does not change the phase state in a contour, hence with the equal power, water and glycol systems are less efficient than Freon systems. However, fluid systems have got such unquestionable advantages as capacity and versatility. Systems with fluid cooling can use a fan coil unit on the roof or in the yard of the building or a heating system of the building as a refrigerant. A liquid can cool air in a server room or can be used as a refrigerant for a separate processor. An unquestionable advantage of fluid cooling is almost unlimited trace length due to the low price of the refrigerant. The most dangerous thing in this situation is a leakage of a conductive agent, but this is unlikely to scare anyone. In this situation, IBM distinguished himself by constructing SuperMUC, which helped to achieve saving 40% of power consumption due to a lack of chillers on a cooling system. Google uses their own developed system in the most of its data centres, where the system of cold and hot aisles is used. One more system with fluid implies immersion of a server into a special mineral oil. Oil is an insulator hence there will be no short circuit. What about energy efficiency, the specialists at Intel, for example, assure that a cooling system in such case consumes 90% less power, and a power consumption of servers decreases as well. Racks for immersed fluid cooling are manufactured by CarnotJet. Such racks can accommodate any servers, however there is a need to pull out all fans out of them.

Picture :1: Fluid cooling

Another factor of versatility is a huge amount of ways to cool a refrigerant. For example, there is a

technology named SeaWater Air Conditioning (SWAC), according to which a Google data centre is built in Finland. From its name it is clear that a heat exchanger, working on cold water from deep sea is used to cool



water that comes to data centre. A classic system of fluid cooling acts as an intermediary between a relatively high temperature inside server rooms, and a cooler (more often a dry cooling tower and a chiller) outside. A dry cooling tower is an airtight cooling contour, where a fluid enters a radiator, which is forcedly blown by air. There are also wet cooling towers, water is sprayed and blown simultaneously inside them. Usually, liquid refrigerant is only prepared in cooling towers or fan coils, by being cooled to ambient temperature. The cooling process takes place in a heat exchanger of a chiller. A chiller is a refrigerator, which operates on Freon and cools the liquid that passes through its cooler to a required temperature.

Picture :1: Chillers installed on a roof

(http://www.quantum-v.ru/)

The same rules are correct for classic fluid conditioning as for Freon systems. Air that had been cooled in an evaporator passes through consumers and is taken from a server room by a cooling system. Despite the fact fluid systems are more versatile and are cheaper in use than Freon ones, their efficiency is lower because of a bigger amount of intermediaries air-chiller-fluid-air. It is evident this scheme is not the best.

It has long been observed that a moist air from reservoirs is always cooler than from plains away from them, just like a sea breeze. For adiabatic cooling systems, there is no need to have backup systems or complicated technical solutions. They are designed according to the principle of wet cooling towers: inside collectors, nozzles sprinkle water into a heated outside air. This dissipated water cools and humidifies air when evaporating. Such system does not only effectively decrease a temperature of an outside air, but also maintains a required level of air humidity. However, there is a new consumable in such systems, water. Therefore, ASHRAE introduced a new term WUE (Water usage effectiveness (PDF)) similar to PUE (Power usage effectiveness). The brightest examples of implementing such systems are data centres of eBay "Mercury" in Phoenix (USA) and Facebook in Prineville (USA).

Picture:2: Adiabatic cooling in action

(http://www.es-engineering.ru/)

Rittal Liquid Cooling Package:

Developed to remove high levels of waste heat from server enclosures, this high density cooling solution utilizes air/water heat exchangers providing uniform, effective and affordable cooling for servers and similar IT equipment. The special horizontal airflow of the Rittal LCP represents an adaptation of this widespread cooling principle, providing cooled air uniformly throughout the complete height of the enclosure.

The liquid cooling unit is a modular, upgradeable, and temperature-neutral cooling concept.

Up to 30kW cooling output, with three cooling modules possible per equipment rack

Controlled variable speed fan and water flow based on actual heat load generated in cabinet

Constant temperature cold air provided at the front intake for optimized equipment use, hot air removed from rear

Even air distribution along the entire height of the front 482.6 mm (19″) mounting angles

Can be bayed between two 42U racks

High energy efficiency in removing waste heat with no temperature impact in the room

Some ideas to make server room cool:

You need some way to pump heat out of the room. I would try a large, high flow fan pointed up the stairs. See if you can get one of those 4 or 5 feet high fans that schools sometimes use.

Every night make a big block of ice in your freezer (the bigger the better - 1-4 cubic feet will work). The next day, set it in a shallow, wide container (you will need one with at least one extra cubic foot of volume than the size of the ice block). Then you get a box fan and set it in the door and have it blow the outside the room air over the sblow hot air out

I have a similar situation. Our server room is a small room 4x4. We cut a hole in the bottom of the server room door and installed a vent to pull cool air in from the office, and cut another one in the top of the door to allow the warm air to come out the top vent. I am surprised at how well that has served us. We keep the office around 72 in the summer, and the server room is never more then 5 degrees warmer.

I think your original idea is best... Just buy some extra tubing at your local hardware store... Most of the units I've seen use what appears to be the flexible dryer ducts and should be easy to duct tape in place.

HVAC guy put a return vent in ceiling and a grate in wall along floor near equipment. Works petty good and didn't cost us that much.

lf all you care about is cheap, then you can get a sledgehammer and open up a hole in the wall and

then stick a box fan in the hole to suck cold air from the adjacent room. Prior to this we were doing fairly OK with a fan/vent combo in the ceiling to suck out hot air and a cool air inlet in the door. I only moved when our server count got too high for the closet to manage.

I was curious as if anyone has ever ran into this problem where the server sits in a closet, and there is not AC vent to keep it cool. I figured maybe a few H members have ran into this problem and knew a bit on internal ac units which require no ventilation.

You don't get internal AC units without ventallation. AC cooling relies on heat dispersing so you will need to have some sort of venting system.

An option you can have is install a large fan in the closet door or multiple smaller fans (just use a hole saw).

Conclusion:

Cooling is a critical part of a data center's infrastructure, and fortunately (or unfortunately), a number of approaches are available to maintain the necessary temperatures to keep your facility's electronic equipment running. Although a complete discussion of all the design concepts associated with cooling infrastructure could easily constitute a large. a brief overview of the options can help you determine which route is best for server to make cool. Number one on the list is to avoid using AC systems designed for humans – known as comfort AC. The server often starts with the cooling infrastructure. This page addresses the basics, hoping to facilitate deeper discussions about server and to mak server cool in different ways without AC.

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