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How Can Datacenters Manage a Drought?

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Much of the United States has been hit with a tremendous drought over the last four years. California, Texas, and Oklahoma have been particularly hard hit, and California has put severe water restrictions in place.

Datacenters are notorious users of great amounts of water to cool their systems via massive chillers. The new NSA datacenter in Utah is reported to use 1.7 million gallons of water per day to cool 100,000 square feet of computer equipment. Microsoft's San Antonio datacenter in Texas uses 8 million gallons of water per month.

How are data centers handling this drought? For the most part, they are continuing to operate as is and guzzling water. Some are having to truck in water. But there are more efficient ways with respect to water usage such as desalination and air economizers. These technologies may be too late for existing datacenters, but they certainly should be considered for new datacenters.

The California drought

The U.S. Drought Monitor reports that 29 of the U.S.'s 48 contiguous states are in abnormally dry or drought conditions. California particularly has been hard hit. California's drought started in 2011 and is one of its worst droughts in over 100 years. 82% of California is currently classified as in extreme or exceptional drought.

California wants to decrease water usage and provide new sources of fresh water. For instance, a large desalination plant is being built near Monterey Bay to convert ocean water to fresh water.

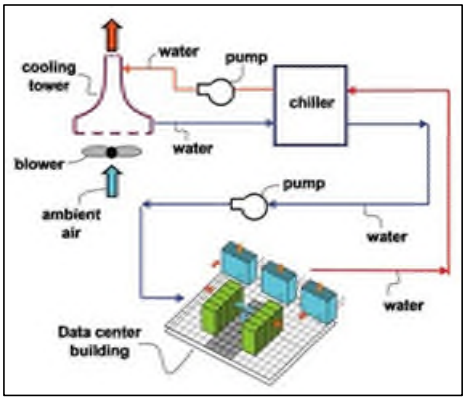
California declared a state of emergency in January, 2015. Governor Jerry Brown announced the first-ever statewide water mandate, requiring cities and towns to reduce water consumption by 25%. Communities in which residents use more than 165 gallons of water per day must cut back their consumption to this level or reduce it by 35%, whichever is less.

The impact of the drought and water restrictions on the agricultural industries has been widely reported. Not so for datacenters. They seem to escape notice.

Use of Water Chillers

California is home to some of the country's largest datacenters and cloud-computing facilities. Over the years, energy consumption has gained a lot of attention, and most datacenters have made major investments in power-efficient servers and other IT equipment. However, water consumption has not gained a lot of attention – until now.

Most datacenters are designed to use chillers to cool water that can be distributed among their equipment to transfer heat to the outside environment. A chiller includes a large cooling tower that cools water through evaporation. Cold water from the chiller is circulated through the datacenter, often through "hot aisles" built to concentrate the heat. Heat is transferred from the equipment to the water, thus cooling the equipment. The resulting hot water is pumped up into a cooling tower where it drips down a sponge-like material and is cooled by evaporation. This process loses water to the environment. The lost water is continually replenished from a public water source.



LE Design Group

Cooling towers have been a component of datacenter design for many years. They are responsible for the tremendous amounts of water needed by data centers. But are there better options?

The answer is yes. Desalination of sea water is one such option. Along these lines, Google has used unpotable recycled water and has even used sea water in one of its datacenters in Finland. Facebook's Oregon facility uses a customized cooling system that recycles water found in the air.

An important new technology finding increasing application is the use of ambient outside air to cool equipment. Known as an air economizer, this technique significantly reduces the amount of water required to cool the datacenter. A companion technology is the use of a water economizer.

WUE

The PUE (Power Usage Effectiveness) measure has been widely used to reflect the power efficiency of a datacenter. PUE is the ratio of the total power used by a datacenter to just that power used by the IT equipment (the excess power is used for cooling, lighting, etc.). PUEs of 1.1 to 1.2 are commonly achieved by the more power-efficient datacenters.

A new measure has now been defined for water-use efficiency. It is WUE (Water Use Effectiveness). It is the ratio of the amount of water used to cool a datacenter to the total power used by the datacenter. It is expressed as Liters/Kilowatt Hour (L/kWh).

Recommendations made by the WUE committee to reduce water consumption include:

- Reduce IT energy use, thereby reducing the cooling demand and water consumption.
- Ensure the humidity control system is optimized and the datacenter is running at the low end of the ASHRAE-recommended guidelines for humidity (5.5° C dew point).
- Optimize cooling-tower operations (if they are used) to increase cycles of concentration.
- Implement best practice airflow management to improve cooling efficiency.
- Operate the datacenter at or near the ASHRAE-recommended upper limit for temperature (allow warmer chilled air and less evaporation of water to produce it).

Facebook has dashboards showing PUE and WUE for their datacenters (1.06 PUE, .35 L/kWh for WUE)

Desalination

One solution to the water usage problem is to increase the supply of fresh water. This can be done by desalination, converting salty sea water to fresh water. Desalination is a working technology used throughout the world to combat the shortage of fresh water. Worldwide, desalination plants convert 1.7 billion acre-feet (that's 2×10^{15} gallons) of sea water to fresh water annually.

Desalination works via a process known as *reverse osmosis*. High-pressure ocean water is forced through a membrane to remove the impurities. Desalination is expensive and requires a lot of energy. It has an environmental impact in that it sucks in and destroys tiny sea life that is critical to the food chain.

Transporting the fresh water is also expensive. Desalination is best used by facilities that are close to the ocean.

Air Economizers

Air economizers pump the ambient outside air across the IT equipment to cool it. The heated air is simply exhausted to the outside, and fresh air is pumped in to replace it. This technique is often referred to as *free cooling*.

Air economization requires that the outside air be cool enough to perform its cooling function of heat-producing IT equipment. However, in a good deal of the world, this is the case for many hours of the day. Even Houston, Texas, provides over 3,600 hours of free cooling annually (out of 8,760 hours per year).

The air can be further cooled by spraying a fine mist into it, thus cooling it via evaporation. This requires significantly less water than a chiller. A mist spray might also be used if the humidity of the air is too low.

If the air is too cold, it can first be heated by the heat generated by the IT equipment.

Rackspace has recently opened a new six-megawatt data center in London. It has no mechanical chillers and boasts a PUE of 1.15. It uses a free-cooling system to circulate air through a closed-loop system serving contained hot aisles. When the air is too warm, it adds evaporative cooling with a water spray. Water for this purpose is harvested from the roof of the datacenter. Rackspace's cooling techniques keep the datacenter room temperature at 24° C (75° F) and the hot aisles at 36° C (97° F).

Water Economizers

With a water economizer, water is brought to the IT equipment with a water loop. The heat generated by the IT equipment is transferred to the water and is then conveyed to an external water heat exchanger where it is cooled by the ambient air environment.

Water economizers are most appropriate when the outside air temperature is below 55° F (13° C) for 3,000 hours per year or more. The datacenter switches to mechanical cooling when ambient conditions are not appropriate.

DX Coolers

DX (direct expansion) coolers are the ones used in home air conditioners and refrigerators. They require no water. Rather, they use a refrigerant and an evaporation coil that is cooled by ambient air to remove the heat.

DX coolers are most appropriate for small datacenters or for small enclosed spaces.

Summary

When we talk about disasters that can take a datacenter down, we usually mean earthquakes, floods, fires, riots, and the like. Hopefully, the datacenters of the future will add “drought” to these disasters. There are several ways to reduce the dependence of a datacenter on fresh water. However, most of these are more appropriate to be designed into new datacenters.

In addition to California, the states of Texas and Oklahoma were also devastated by a four-year drought. However, their droughts ended suddenly and violently. Massive storms deluged the areas. Houston received ten inches of rain in one night. The Brazos river flowing through Houston exceeded its twelve-foot flood stage level and raised to 48 feet, sending massive amounts of water into the city, washing away homes with people in them. At least 26 deaths were reported throughout the area.

This is a reminder that disasters of any kind can occur without warning. Datacenters must be prepared to survive any disaster that nature may throw at them.

Acknowledgements

Material for this article was taken from the following sources:

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