the Availability Digest

www.availabilitydigest.com
@availabilitydig

Data Centers Consume Inordinate Amounts of Energy

August 2016

The explosion of digital content, big data, e-commerce, and Internet traffic is positioning data centers to be among the largest consumers of electricity. Data centers are among the fastest-growing users of electricity in the United States.

In 2013, data centers consumed an estimated 91 billion kilowatt-hours of electricity, more than twice that of all households in New York City. If worldwide data centers were a country, they would be the world's twelfth largest consumer of electricity, ranking somewhere between Spain and Italy. Data-center energy consumption is estimated to increase by more than 50% by 2020.

The world's aging power infrastructure is unable to keep up with the electricity demand in many developed countries.

Power Consumption from Data Centers

Every minute:

- 204 million email messages are exchanged.
- 5 million searches are made on Google.
- 1.8 million "likes" are generated on Facebook.
- 350,000 tweets are sent on Twitter.
- $272,000 of merchandise is sold on Amazon.
- 15,000 tracks are downloaded via iTunes.

According to EMC Corporation, about 100 megabytes of new information is created every minute for every human being on Earth. The need to analyze this data is following suit. Businesses are beginning to realize that the power required to support their High Performance Computing clouds, clusters, and supercomputers is not growing as fast as their needs.

The processing power required to service all of this activity plus that of corporations are provided by twelve million servers housed in three million data centers (from closets to hyper-scale cloud computing centers). Hyper-scale cloud computing data centers, such as Amazon, Google, Microsoft, and NetFlix, represent only a small fraction of the power consumption of all data centers. As shown in Table 1, the vast majority of data-center energy is consumed by small, medium, and large corporate data centers.

A growing segment in this collection of data centers is multi-tenant data centers. These data centers provide the compute, storage, and networking facilities that companies can lease to provide their processing needs. Multi-tenant data centers typically charge by the space (or by the rack). Associated with each rack is a power allotment. The customer does not pay for power so long as the power consumed by the rack is less than that allotted.

Table 1: Estimated US data-center electricity consumption by market segment (NRDC - 2011)			
Segment	Number of servers (millions)	Electricity Share	Total US Data-Center Electricity Use (billion kiloWatthours/yr)
Small and Medium Server Rooms	4.9	49%	37.5
Enterprise/Corporate Data Centers	3.7	27%	20.5
Multi-Tenant Data Centers	2.7	19%	14.1
Hyper-Scale Cloud Computing	0.9	4%	3.3
High-Performance Computing	0.1	1%	1.0
Total	12.2	100%	76.4

The information and technology ecosystem now represents about 10% of the world's electricity consumption. It takes 34 power plants, each generating 500 megawatts of electricity, to power all data centers in operation today. Another 17 power plants will be required by 2020 to handle the growth in data-center power utilization.

Causes of Data Center Power Inefficiencies

A primary cause of data-center power inefficiency is that in most organizations, the department responsible for data-center management is separate from the one paying the electric bills. Only about 20% of IT departments pay their electric bills.

In multi-tenant data centers, the situation is even worse, as those that provision IT equipment and those that are responsible for the payment of the electric bills are carried out by different companies. Thus, there is little incentive to worry about power efficiency.

A single refrigerator-size server rack in a data center consumes as much power as an average household. Yet, the average server in such a rack operates at no more than 12% to 18% of its capacity while it continues to draw 30% to 60% of its maximum power. This is because it is provisioned to handle its peak loads, which may only occur occasionally.

Even worse, about 30% of all servers are "comatose." They are no longer used. Typically in the past, when a department wanted to deploy a new application, it would acquire a server for that application. When the application was no longer needed, the server would not be recycled. It simply remained on the data-center floor drawing power.

Thus, much of the energy consumed by data centers is used to power twelve million servers that do little or no work most of the time.

The situation is even more striking in multi-tenant data centers. The IT equipment and the power to drive that equipment are paid not by separate departments, but by separate companies. Since each rack is given a power allotment by the data center, the customer does not pay for power if his servers in the rack draw less power than that allotted. Of course, if the servers begin to draw more power, the customer is motivated to attempt to control the power consumption of his servers. It is only then that the customer may be more motivated to invest in more efficient equipment.

IT managers are extremely cautious about implementing aggressive energy management programs because they are concerned that such measures could threaten uptime. Uptime is one of the primary metrics upon which their performance is judged.

Steps to Take to Improve Data-Center Power Efficiency

There are several steps that can be taken by data-center administrators to improve power efficiency:

- Shut down unused servers. However, data-center administrators cannot always tell whether a server is truly comatose. It may appear that it is forever idle. However, it may be used at the end of each month to run a critical application. Data-center administrators are therefore unwilling to shut down servers that appear to be comatose.

- Extend the use of virtualization. Virtualization is used extensively in the hyper-scale cloud data centers, achieving average server utilization of 50% to 60%. However, virtualization has yet to make major inroads into smaller data centers. By using virtualization, smaller data centers could significantly increase their server utilizations and still provide the capacity for peak workloads.

- Focus on long-term total cost of ownership rather than the upfront procurement costs of servers. Purchase Energy Star servers, which cost more to procure but are less expensive over the long term when energy costs are considered. The use of such servers saves not only in the cost of power to operate the servers but also in the cooling costs for the data center, since these servers generate less heat.

- Use data deduplication to reduce the need for data-storage systems.

- Use solid-state storage. SSDs generate much less heat than rotating hard disks and therefore require less cooling.

- Raise the operating temperature in the data-center room from the norm of 64 degrees Fahrenheit to 75 degrees, a temperature that standard equipment today can tolerate. Some new equipment now available can operate satisfactorily in temperatures as high as 95 or 100 degrees Fahrenheit.

- Have multi-tenant data centers charge customers directly for the power they use rather than simply giving them a power allotment.

- Consider moving the data center to an area with abundant, clean, and affordable power such as Iceland, Norway, Sweden, and the Canadian province of Quebec. Many of these areas are rich in hydroelectric and geothermal energy. Such northern areas can also provide cool outside air to reduce the power demand of cooling.

Summary

If just half of the potential energy savings were realized by today's data centers, they could slash their electricity consumption by 40%. This is equivalent to the electricity consumption of all the households in the U.S. state of Michigan.

Acknowledgements

Information for this article was taken from the following sources:

IT now 10 percent of world's electricity consumption, report finds, *The Register*; August 16, 2013.
Data centers are the new polluters, *Computerworld*; August 24, 2014.
America's Data Centers Consuming and Wasting Growing Amounts of Energy, *NRDC**; February 6, 2015.
Balancing the data vs. power equation, *Data Center Dynamics*; July 18, 2016.
America's Data Centers Are Wasting Huge Amounts of Energy, *NRDC**; undated.
Trends in data center power usage, *Tech Target*; undated.
* NRDC – National Resource Defense Council