Memory Selection Considerations for Energy-Efficient Data Centers

by Roland Barth and Jeff Hnatek, Qimonda AG

The current strong interest in data center energy efficiency is not surprising when you look at the basic numbers. Data centers and server farms use almost ten times the energy per square foot as office space[1], and a very large data center can spend more than $75 million a year on server power alone. This energy bill has two components: the power needed to operate the servers, and a large multiplier that is used to keep the equipment cool. Power consumed translates to heat generated and higher potential failure rates. To control heat-related issues, a typical data center may consume 100 W of cooling power for every 100 W used to power a server[2]. Clearly, reduction of server power consumption, and heat generation, are tremendously important in controlling the energy demands of data centers.

The DRAM memory used in servers typically represents the second largest power drain in the system, after the processors. On a blade server unit, for example, the memory subsystem contributes as much as 15% to power usage[3]. For 4-U or 6-U servers, memory subsystem power is even greater because of higher memory density per server. Server purchasers should look at several avenues to ensure the best possible power profile for the memory system.

Integration

Because each individual component consumes power, higher levels of integration through part-eliminating techniques can reduce the power footprint. In addition, designers should look for DIMM (dual in-line memory module) architectures that are optimized for power considerations. For example, stacked, higher density DRAM components can reduce component count for equivalent module density by half.

Low-Wattage Parts

Use of lower wattage parts results in less heat generation, increased reliability and reduced maintenance costs.

Designers can select DRAMs that are optimized for minimum power consumption in the server environment; for example, DIMMs based on Qimonda DDR2 DRAMs have been shown to consume up to 30% less power[4].

The power footprint of Fully Buffered DIMMs (FB DIMMs) now commonly used in servers also should be looked at closely. The industry specification for 4-Gbyte FB DIMMs in servers is 41.6 W. In a typical data center consisting of 5000 servers, total power consumption is:

41.6 W x 5000 = 208 kW x 24 hours x 365.25 days = 1,823,328 kW-hr per year

This can be significantly reduced. For example, such power-optimized FB DIMMs such as the 1-Gbyte modules from Qimonda consume 8.7 W, which in a 4-Gbyte configuration would, at

34.8 W, be about 15% below the standard specification. Assuming 4 Gbyte of such FB DIMMs are used per server, the power calculation would be:

4 x 8.7 W x 5000 = 174 kW x 24 hours x 365.25 days = 1,525,284 kW-hr per year

Based on a $0.12 /kW-hr electricity rate, which is at the low end of the $0.12 - $0.15 non-residential electric rate available from PG&E -- a Northern California utility -- this represents a cost savings of approximately $36,000 a year.

Even the simple step of looking for optimized heat sink design on DIMMs -- enhancing heat dissipation without increasing airflow provided by a power-consuming cooling fan -- can lower the energy footprint.

System Considerations

Because the real goal is to reduce total system power consumed by data centers, the server designer should look for the best ways to achieve an optimum power/efficiency ratio, preferably using the definitions supplied by The Green Grid in its PUE (power usage effectiveness) and DCE (data center efficiency) metrics for estimating the energy efficiency of data centers[5]. This involves looking at such things as the use of heat spreaders, which can help decrease cooling demands. Increasing spacing between DIMM sockets whenever possible will improve heat dissipation on the DIMM level and, consequently, reduce power burned by cooling fans.

Design With a Data Center Perspective

To ensure that a data center achieves maximum performance with the lowest power, previously separate planning groups must begin to work more closely together to consider the entire cost of ownership when server purchasing decisions are being made. While the purchase price of an energy-efficient server may be greater, it will be less expensive in the long run if its capabilities are properly exploited. From the system builder point of view, ensuring reduced long-term cost of ownership means getting serious about increasing levels of integration, using low-wattage parts and looking at new data center-oriented design considerations that will help reduce overall power consumption.

References

1 *American Almanac 2006*, US Energy Information Administration

2 Koomey, Jonathan G, *Estimating Total Power Consumption By Servers in the US and the World*, final report for study commissioned by AMD, February 15, 2007

3 *The Ring of Fire: DRAM Power Consumption In Infrastructure Applications*, MemCon/San José presentation, September 2006 https://www.denali.com/news_pr20060426.html

4 Qimonda power measurements documented in the same MemCon/San José presentation, September 2006 - https://www.denali.com/news_pr20060426.html

[5] *GREEN GRID METRICS: Describing Datacenter Power Efficiency*, Technical Committee, White Paper, February 20, 2007, The Green Grid -- http://www.the**greengrid**.org/gg_content/**Green_Grid**_Metrics_WP.pdf

About The Authors

Dr Roland Barth, is Director of Product Definition at Qimonda AG. He is based in Munich, Germany. Roland can be reached at: Roland.Barth@qimonda.com, +49 (89) 60088-1484

Jeff Hnatek is Product Marketing Manager at Qimonda, North America. He is based in San José, CA. Jeff holds a BSEE from Santa Clara University and an MBA from University of the Pacific, Stockton, CA. He can be reached at: Jeff.Hnatek@qimonda.com, +1 (408) 501-7147.