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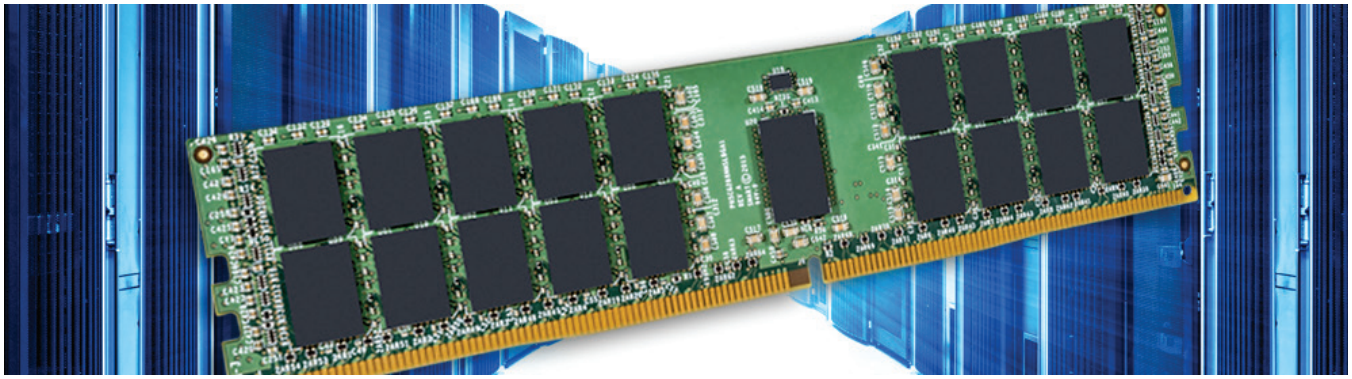

EcoMemory™

Intelligent Power Management
A New Tool for Data Centers – Reduce Power Consumption & Heat

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White Paper M-WP005

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Executive Summary

According to the Natural Resources Defense Council, data centers are one of the largest and fastest growing consumers of electricity in the United States. In 2013, U.S. data centers consumed an estimated 91 billion kilowatt hours of electricity, enough electricity to power all the households in New York City twice over, and are on-track to reach 140 billion kilowatt-hours by 2020[1]. Some large server farms operated by well-known internet brands provide shining examples of ultra-efficient data centers. Yet small, medium, and corporate data centers are responsible for the vast majority of data center energy consumption and generally operate much less efficiently. One of the largest issues and opportunities for energy savings includes the underutilization of data center equipment.

For each watt of electricity used by data center servers, nearly an additional watt is used for data center infrastructure. These additional watts mainly power the cooling systems that draw the heat out of the building, but they also sustain huge backup power sources designed to prevent even the slightest power interruptions. These additional measurements alone decrease the efficiency of data centers down to 50 percent. In a recent study commissioned by the New York Times, consulting firm McKinsey & Company found that only six to 12 percent of the power consumed by servers in the average data center is used to perform calculations[2].The rest is wasted on idle servers in standby mode.

Idle servers provide two key services: they store old data that is rarely if ever accessed, and secondly, they offer over-provisioning to accommodate spikes in server demand or future storage needs. Most data centers overbuild capacity knowing that maintaining surplus server capacity is much cheaper than lost business if they are not prepared for an upside. EMC and IDC together estimated that more than 1.8 trillion gigabytes of digital information were created globally last year. All of that data needs to be stored, even though the vast majority of it will rarely if ever be accessed again.

Introduction

EcoMemory is a quantum advance in power efficient memory. SMART Modular, in collaboration with Packet Digital, has integrated the Packet Digital ODP (On-Demand-Power®) integrated circuit onto a Registered DRAM module. The power management chip adjusts supply voltage based on memory activity. Although the power management IC significantly reduces power consumption and heat generation, there is no change in performance, and changes to the host system are not required.

Since EcoMemory is a drop-in replacement for standard RDIMMs, they are a new tool for data center operators to reduce power consumption and/or heat. There are many uses for EcoMemory including:

Lower Electricity Costs: Savings can range from tens of thousands of dollars to hundreds of thousands of dollars, and can even reach one million dollars per year in cost savings.

- Rack Utilization/Floor Space: Create fewer, higher density racks.
- Power Circuit Overhead: Reduce potential power overload/outage on heavily used circuits.
- Increased Performance: Reduce the potential for CPU throttling.
- Lower electricity costs: Compensate for inefficient cooling.

EcoMemory modules are available in all densities, and comply with industry standard (JEDEC) specifications.

EcoMemory Saves Power

The amount of power savings EcoMemory provides depends on the host workload. Power savings are highest when memory is idle. It is well documented that the majority of servers in a data center are idle most of the time.

Power Savings per Module

Figure 1 illustrates the measured power savings for idle, mixed and memory intensive work loads. Power savings are realized across all current states (IDD0 through IDD7).

Work Load	Module	Standard RDIMM (W)	ECO-RDIMM (W)	Savings (W)	Savings (%)
Linux (idle)	16GB DDR4	1.08	0.8	0.28	25.9%
Memtest 86+	16GB DDR4	2.99	2.46	0.53	17.7%
SMART HPL	16GB DDR4	4.29	3.96	0.33	7.7%

Figure 1: Measured power savings for idle, mixed and memory intensive work loads

Power Savings per Server

The amount of memory used in servers today continues to grow, and as it does, more and more power is being consumed by memory. Also, the power supplies in today's servers are very inefficient and waste significant power during the AC to DC and DC to DC power conversion process. A recent article illustrates that up to 36 percent of power usage in a server is attributed to losses during power conversion processes[3]. EcoMemory not only saves power directly, it also reduces upstream power losses that occur during power conversion.

The graph below depicts the measured power savings in a server configured with sixteen 16GB DDR3 EcoMemory modules vs sixteen standard RDIMMs. Based on a Prime 95 work load, total power saved is ~15W. The same server running idle resulted in ~20W of power savings.

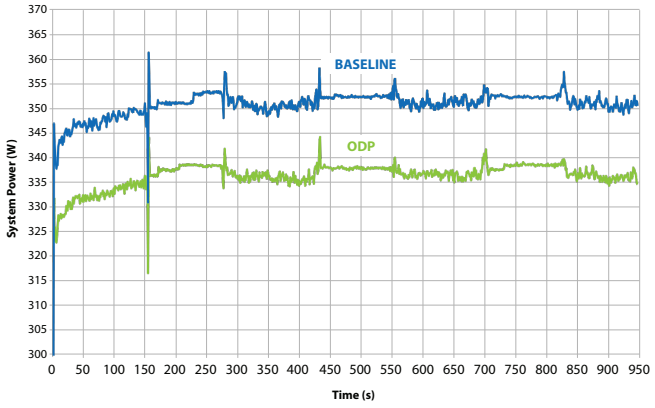

Figure 2: Measured power savings in a server configured with sixteen 16GB DDR3 EcoMemory modules vs sixteen standard RDIMMs

Power Savings per Rack

SMART Modular recently completed a rack level study with a large data center. The objective was to reduce the power consumption per server with the goal of installing two additional servers in the rack without making any other changes. Sixteen 16GB DDR3 EcoMemory modules were installed into twenty two 1U servers. After several weeks of analysis, the data center concluded that use of ecoMemory resulted in ~400W of power savings and the objective of installing two more mid-range servers was achieved.

EcoMemory Runs Cooler

As expected, EcoMemory's reduction in power consumption translates directly into a reduction in generated heat. The thermal imaging analysis below compared a standard 16GB DDR4 DIMM to an equivalent ECO-RDIMM. The ECO-RDIMM ran ~10 degrees Celsius cooler than the standard RDIMM.

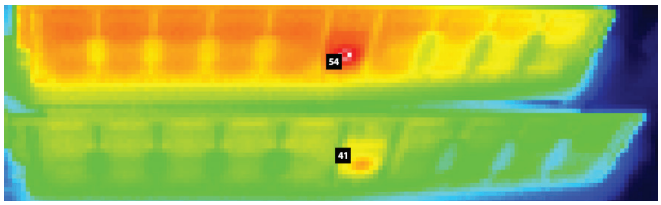

Figure 3: Tyan DDR4 Server Motherboard, 16GB DDR4 1 RDIMM (top); 1 ECO-RDIMM (bottom)

There are many benefits associated with running lower temperature DRAM modules. The obvious and biggest benefit is less cooling required by the data center infrastructure. Less obvious is a higher reliability module, and possible higher server performance due to a reduced potential for CPU throttling.

How EcoMemory Works

The ODP power management IC regulates the operating voltage (VDD) based on real-time module current consumption. Since power consumption is proportional to the square of the supply voltage, adjusting VDD can greatly reduce DIMM power consumption. The ODP power management IC is programmable and can be set very conservatively or aggressively. After thousands of hours of testing in numerous platforms, SMART has implemented the optimum setting which provides significant power savings without affecting module functionality. EcoMemory works in all servers regardless of CPU vendor or CPU settings.

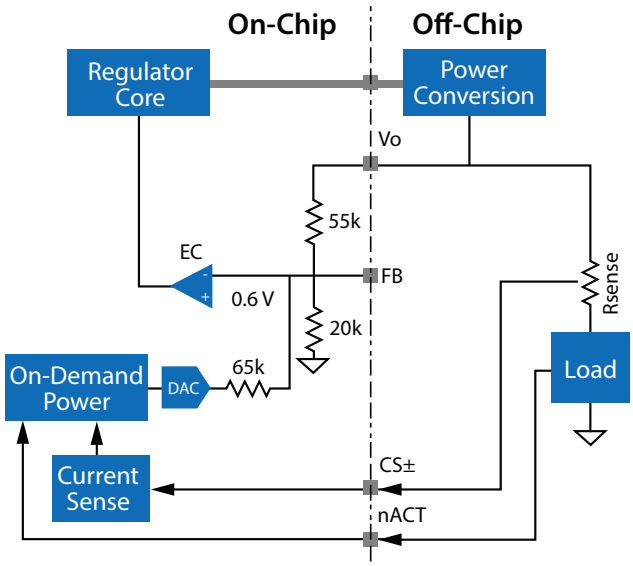

Figure 4: ODP Block Diagram.

Conclusion

EcoMemory is a new, quantum advance in power efficient memory. EcoMemory is a valuable tool for data center operators to reduce power and heat, especially as more and more memory is deployed per server. EcoMemory benefits are the greatest in idle servers; and idle servers dominate most data centers today. Since EcoMemory modules runs cooler, they are inherently more reliable and will reduce the potential for CPU throttling, thereby increasing server performance. EcoMemory has a direct effect on all components of a Total Cost of Ownership (TCO) calculation with the obvious benefit being electricity cost reduction.

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2. James Glanz, "The Cloud Factories: Power, Pollution and the Internet", www.nytimes.com/2012/09/23/technology/data-centers-wastevast-amounts-of-energy-belying-industry-image.html
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