Zero-Maintenance Cache Protection

Technical Brief

Reduced Data Center Operating Costs and Maximum Protection for Cached Data

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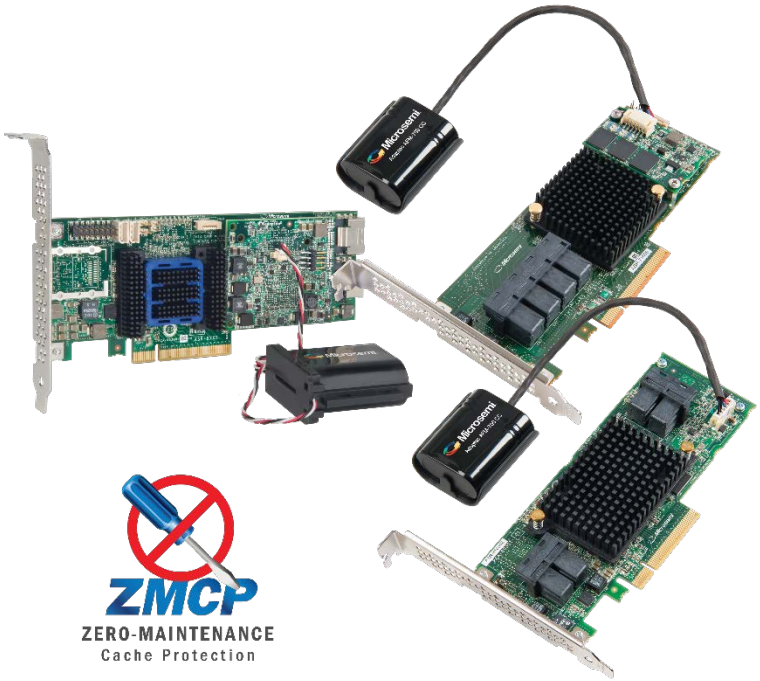
Microsemi
Power Matters.™

Zero-Maintenance Cache Protection

Microsemi Adaptec 12 Gbps and 6 Gbps RAID adapters with Zero-Maintenance Cache Protection (ZMCP) provide maximum protection for cached data and eliminate the substantial costs and environmental impact of complex, messy, and expensive Lithium Ion batteries, while improving cache protection and performance.

Figure 1 Microsemi Adaptec RAID Adapters with ZMCP



Features

- Low operating costs
  - No installation, monitoring, maintenance, disposal, or replacement costs due to batteries
- No data loss from power failures
  - Replaces lithium ion batteries
- Maintenance-free cached data protection
  - No need to monitor battery charge level
  - No shutdown required for battery replacement
  - Protects data indefinitely—no need to rush to restart systems before the battery runs out
  - Stores protected data for years
- Instant RAID cache protection
  - Charges in minutes instead of hours

    - RAID performance optimized immediately
- Environmentally conscious
    - No toxic battery disposal
    - Simplified IATA compliance
- Flexible design
    - ZMCP 3.0 is available as an option for Series 8 and Series 7 adapters (AFM-700)
    - ZMCP 2.0 is available as an option on Series 6/6T adapters (AFM-600)

The Need for Cache Protection

The adoption of RAID 5 and 6 continues to grow in enterprise storage systems as users continue to be concerned about optimizing capacity utilization for rapidly growing data sets. Additionally, in applications where spinning media (hard disk drives) are used, the use of DRAM caching can greatly enhance performance and reduce latency by up to 4x in real-world scenarios, even without the use of RAID. However, optimal performance can suffer unless the system is operated with all available caches enabled, including write-back caching.

With adapter write cache enabled, data is stored in the adapter's memory and can be lost when a system power outage occurs. The traditional protection method in this scenario is a battery backup unit (BBU) installed directly on the adapter. This battery is used to maintain the data of the on-board memory cache until power can be resupplied to the unit.

Zero-Maintenance Cache Protection

Despite their obvious value, BBUs are not the optimal solution from a capital expense (CapEx) or an operating expense (OpEx) standpoint: they require constant monitoring, maintenance, and replacement, and old batteries must be disposed of in an environmentally responsible manner.

Series 8, Series 8Q/8ZQ, Series 7, Series 7Q, Series 6/6T, and Series 6Q/6TQ SAS/SATA RAID adapters offer a different approach: Zero-Maintenance Cache Protection.

The basic idea of ZMCP is to detect the loss of power to the adapter and then to copy the data in the onboard adapter cache to non-volatile location—in this case, NAND flash memory of a type similar to that used in USB thumb drives and solid state disks. This process is supported by a super capacitor that keeps the necessary parts of the adapter active for the time required to perform the NAND flash copy. When power is finally restored to the adapter, the data in the flash memory is copied back to the onboard adapter cache and operation resumes as normal with all outstanding I/O requests preserved.

Once the data has been copied to the flash memory the adapter no longer needs power in order to preserve the data.

ZMCP 3.0 is enabled through the AFM-700 Microsemi Adaptec Flash Module. The AFM-700 kit is available as an option for Series 8 and Series 7 adapters, and includes a mounting plate to secure the cap module to an unused PCI slot. ZMCP 2.0 is enabled through the AFM-600 Microsemi Adaptec Flash Module, which is available as an option for Series 6/6T adapters.

The optional kits give Series 8, Series 7, and Series 6/6T owners the flexibility of adding ZMCP at any time, or not adding it at all, depending on budgets and requirements.

AFM-700 and AFM-600 modules have an operating temperature range of 0 °C to 50 °C, enabling both to withstand higher temperatures than typical BBU batteries.

ZMCP 3.0 (Third-Generation) Advanced Features

The AFM-700 module for Series 8, Series 8Q/8ZQ (12 Gbps), and Series 7 and 7Q (6 Gbps) adapters introduces several new features not found in previous generations.

Note: Second-generation ZMCP (available on Microsemi Adaptec Series 6/6T RAID adapters through the AFM-600 module) shares the same benefits over a BBU using eMLC flash memory and provides only basic health status information.

Real-time Health Monitoring

Data center administrators can instantly check the temperature, capacity, and remaining lifetime of the super capacitor through Microsemi Adaptec maxView, a web-based interface that makes it simple to view, monitor, and configure all Microsemi Adaptec RAID adapters in a system. Real-time health monitoring is also available through the Microsemi Adaptec ARCCONF command line utility.

Instant Capacity Level Monitoring

The AFM-700 allows capacity to be tested instantly without disrupting operations or impacting performance. In order to check the remaining capacity of a BBU, it must be discharged and then recharged, which can take up to 24 hours and leave cached data vulnerable in the event of a power failure.

Backup Power to the Adapter

The adapter logic monitors the loss of host power and switches over to backup power from the AFM-700's super capacitors.

New Design

The AFM-700 is tightly integrated with fewer parts, which both reduces the footprint and achieves a higher Mean Time Between Failures (MTBF). Additionally, the AFM-700 uses SLC NAND flash (versus standard NAND flash used in previous versions), which allows for better throughput, more reliable and faster transfers of backup cache data, and a longer product life cycle.

ZMCP Benefits Relative to BBUs

While BBUs have been an acceptable cached data protection solution for years, there are numerous hard costs, labor costs, and risk factors associated with managing and replacing BBUs after the initial purchase has been made.

Microsemi Adaptec RAID adapters with Zero-Maintenance Cache Protection eliminate all these pitfalls.

Table 1 ZMCP Benefits Relative to BBUs

Lithium Ion Batteries	Consequences	Microsemi's ZMCP
Must be charged before they can be used	Cache is not enabled until the battery charge is complete	Charges instantly during system boot, enabling full protection
Must be "conditioned" during initial deployment	Add hours to the deployment process	No action required
Must be replaced on a regular maintenance cycle	Keep staff on hand to perform maintenance	No action required

Lithium Ion Batteries	Consequences	Microsemi's ZMCP
Must be continually monitored so that failing batteries can be replaced	Add monitoring capability and corrective action process to operations process	No action required
Must be fully discharged then recharged in order to test capacity	Process can take 24 hours and leave cached data vulnerable to a power failure	Instant capacity monitoring with no disruptions
A failed battery must be replaced within 72 hours, perhaps less	Stock batteries in each location for urgent replacement	No action required
Must be correctly disposed of	Create, staff, and fund a disposal process	No action required

ZMCP Saves You Real Money

While the logic behind the Zero-Maintenance Cache Protection approach is relatively compelling, the actual financial impact is even more so. To compute these savings, we must look at the ways that people approach their existing BBU solutions.

Savings for the Meticulous BBU User

In this model, we assume several things about the way that the owner handles a card with a BBU:

- They purchase a new battery every year, as recommended, and keep a couple of replacements on hand all the time to take care of unexpected events.
- They carefully schedule downtime for their users to change the battery. They attempt to deploy a replacement device to take up the load while the primary server is out of action. Several individuals in the IT department must usually coordinate their efforts to make this happen.
- Replacement batteries are allowed to fully charge before putting a system back into operation.
- Systems are continuously monitored to detect a failing battery.

In this case, we can assume that the chance of losing data due to a power failure happening while the battery is out of action is very small. The costs of this methodology include:

- Capital expense of purchasing batteries—one per year for four years, plus one extra to take care of unexpected issues.
- Operating IT costs to install the initial device, plan downtime, replace batteries, and recharge them.

- Potential “overtime” or “disruption” costs when a power failure occurs and systems have to be turned back on within the 72-hour battery charge window—potentially disrupting other activities, or occurring during the night, on a weekend, or over a holiday period. Even in the best case, the pressure to repower systems has an impact.
- Productivity impact on other users.

In an ideal world, the chance of losing data in the latter example would be zero due to all the planning. However, in reality it never is. The following table illustrates the total cost of ownership (TCO) for a BBU solution:

Table 2 Total TCO for BBU-Based Solution

Item per Server	Impact Over 4 Years	Cost per Item	4 Year Cost[1]
Batteries	4	$175 each	$700
IT manpower			
Initial installation	.5 hours	$20/hour	$10
Downtime preparation	1.5 staff-hours, 3 times	$30/hour	$135
Battery replacement	1 hours, 3 times	$20/hour	$60
Monitoring	30 seconds per day	$20/hour	$240
Productivity loss	5 people, 15% impact	$40/hour	$800
Activity cost of power loss	3 hours, 30% chance of occurring, 8 incidents	$50/hour	$360
Total			$2,305

1. Based on single server model.

Savings for the On-demand Replacement BBU User

The second model to consider is the BBU user who waits for the alert light to come on before doing anything.

To compute the impact of this scenario we assume:

- A replacement battery had been purchased at the time of the initial installation and is sitting on a shelf somewhere, ready to go. Another new battery is purchased to replace this one.
- The server is immediately taken out of service and, because this is an unplanned event, a relatively large number of people have their productivity affected.
- Because users are waiting to get back on the affected system, replacement batteries are NOT allowed to fully charge before putting the server back into operation. This minimizes the amount (and cost) of downtime for each replacement, but exposes the system to potential data loss while the battery is charging. We assume the system takes two hours to fix, and users are allowed access after another three hours—a net total of five hours of lost work for each affected user.
- Systems are continuously monitored to detect a failing battery.

Table 3 TCO for an On-demand BBU Solution

Item per Server	Impact Over 4 Years	Cost per Item	4 Year Cost
Batteries	4	$175 each	$700
IT manpower			
Initial installation	.5 hours	$20/hour	$10
Downtime preparation	0	$30/hour	$0
Battery replacement	2 hours, once	$20/hour	$40
Monitoring	30 seconds per day	$20/hour	$240
Productivity loss	40 people, 100% impact, 5 hours each incident	$40/hour	$8,000
Activity cost of power loss	3 hours, 30% chance of occurring, 8 incidents	$50/hour	$360
Lost business cost	2 hours of system downtime, $50M per year, 10% impact	$570/hour	$1,140
Total			$10,490

We have also included an impact on the business itself because this type of downtime is unscheduled. The cost of these instances is hard to compute, and estimates calculated by directly-impacted parties are sometimes as high as $500,000 per hour or more. We take a much more conservative approach and simply assume that the impacted device has a 10% impact on a business valued at $50 million per year.

The Bottom Line on Total Cost of Ownership (TCO)

Obviously, there are other scenarios that we could consider, but we have considered two reasonable cases. The net result is:

Table 4 Summary of TCO for a BBU Solution

Methodology	Cost Over 4-Year Lifetime
Taking proper care of your BBU	$2,305
Reacting to BBU emergencies	$10,490 (Plus data loss risk)
Zero Maintenance Cache Protection	Cost of the ZMCP module

Conclusion

By eliminating costly BBU technology and related expenses, ZMCP offers the industry's most complete and efficient data protection solution available today. ZMCP is available as an option for Series 8, Series 7, and Series 6/6T RAID adapters. ZMCP is included with Series 8Q/ZQ, Series 7Q, and Series 6Q/6TQ RAID adapters.

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