Battery-Free Cache Protection

Lenovo ThinkSystem DS2200, DS4200, DS6200

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Introduction

Lenovo's unique technology, providing battery free data protection, provides industry-leading fault tolerance, data reliability and peace of mind. Battery free data protection replaces storage system batteries with far superior, capacitor based technology to protect RAID controller cache in case of power failure.

Batteries are an unpredictable and fault-sensitive technology. Instead of using batteries, the Lenovo ThinkSystem DS2200, DS4200, and DS6200 arrays utilize fault-tolerant and extremely robust Super Capacitors. This technology not only protects cache better than batteries, it lasts longer, charges faster and is environmentally friendly.

In addition, this technology reduces costs, improves end-user experience and eliminates the need for periodic battery maintenance. Battery free data protection does not require lengthy battery charges at the time of initial installation or after power restores. This permits the array to operate in high performance, write-back cache mode within minutes, instead of hours, based on traditional battery technology.

Super Capacitors plus Compact Flash

When power fails, the most common method to protect data in cache is to hold the data in the system memory, placing memory devices into low-power, self-refresh mode and maintaining power only to this small section of the system circuitry for the required period of time.

But as storage systems gain larger and larger memories for enhanced performance, and as they become smaller and more functionally compact, the power requirements for extended backup becomes much more difficult,

especially if the storage system is also subject to more stressful environmental conditions. As energy requirements grow and space availability shrinks, storage system architects are faced with alternative methods of guaranteeing data integrity. When factors exceed the ability of common battery backup mechanisms to perform reliably, careful consideration must be given to the cache backup design.

In the last few years, two devices have come to the aid of storage system architects to address these issues: Super Capacitors and solid state compact flash. Solid state flash memories, configured as disk emulation devices equipped with embedded controllers, have high performance and high reliability due to the same kind of mechanisms used in high performance disk drives: error detection and correction, buffering, load balancing (avoiding concentrated writes to one area) and bad-block mapping.

These solid state devices also provide higher temperature tolerances, shock and vibration resistance, and resistance to many types of electric and magnetic fields. Their power-consumption is low and the sustained write rate for premium devices exceeds that of the best micro disk drives, allowing write rates of 6 to 9 Mbytes per second. This translates into a backup of 1GB of cache write space in two to three minutes, plus providing practically unlimited (10-year) data storage.

Storage System Batteries: The Old Approach

The problem with using batteries is their relatively high discharge rate. Batteries typically discharge at a 20-hour rate for greatest efficiency, or, at a minimum, a one-hour discharge rate for high performance Lithium Ion batteries. Not only does their effective capacity drop, but their internal energy losses increase, causing substantial internal temperatures to increase. When storage systems are subjected to elevated temperatures, this only exacerbates the inherent weakness of a battery's reliability.

Systems that need to operate continuously at 40ºC, and for limited periods at higher temperatures, find that batteries quickly fail to provide service. Batteries (and their chargers) are designed to charge at no more than 45ºC, allowing only a 5ºC temperature rise within the equipment at 40ºC ambient and no operational capability in an extended temperature range. At higher temperatures, battery life degrades drastically no matter what the other operating parameters are. Often, batteries cannot be charged, meaning that the storage system cannot support cache write-back (buffering).

Battery Free Architecture

In a single storage system, super capacitors, based on Aerogel carbon technology, are packaged in a bank of four parallel capacitors. They are arranged in a removal pack that is electrically insulated and has a single cable that attaches to the main board using a keyed/latched Molex mini-fit socket. The pack is mounted directly on the main board.

The storage controller monitors each super capacitor voltage level, the charging current level and the average pack temperature. The storage controller also controls the charger, enabling it to monitor the super capacitor four-pack under load and during a charge. Restoring backup capability in the super capacitor pack takes only a few minutes. Active balance equalization is used to assure even voltage distribution across the capacitors.

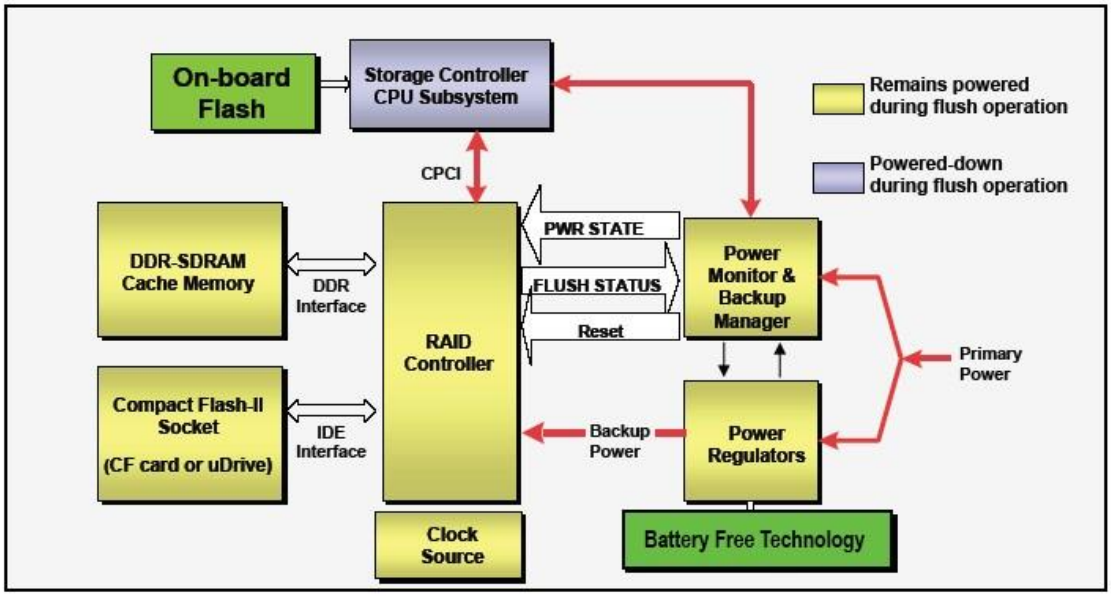

Figure 1 - Block Diagram of Battery Free Technology

The super capacitors have a wide operational range, whereas batteries are limited to 45ºC charging and 65ºC discharging. At elevated temperatures, batteries must be replaced regularly, sometimes annually, as they degrade over time and temperature. A Li-Ion battery lifespan is only rated for three years, typically independent of temperature. The much longer life (how much longer, can we give a number) of the super capacitor eliminates the need for frequent replacement of cache protecting batteries during the life of any Storage System, which saves on maintenance costs and performance degradation during the full pre-maintenance period with insufficient battery protection.

Battery Free Ensures High Reliability

The super capacitor pack and compact flash memory in each controller module provides end-users with unlimited cache memory backup time. The super capacitor pack provides energy for backing up unwritten data in the write cache to the compact flash in the event of a power failure. Unwritten data in compact flash memory is automatically committed to disk media when power is restored. The super capacitor pack also extends the upper operating temperature and significantly increases RAS (reliability, availability and serviceability) by eliminating batteries altogether.