PowerEdge Product Group

Direct from Development

BATTERIES VERSUS SUPERCAPACITORS

Why Dell EMC PERC Controllers Use Batteries

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This tech note provides an overview of the critical differences between Lithium Ion (Li Ion) battery and Supercapacitor (Supercap) technologies, and the key considerations that went into selecting Li Ion technology as the preferred choice for the newest Dell EMC PowerEdge™ RAID controller (PERC) designs.

Pros and Cons:

- Growing non-volatile memory (NV) densities require a dense solution. Battery makes more sense because of the size of a supercap (SC)
  - Very large packaging due to number of caps required for power dump
  - No place to mount a huge SC
- Major cooling challenges with SC vs. battery
- Have to be positioned in a place for maximum cooling.
  - SCs run very hot and if not cooled properly will fail more quickly

Dell EMC servers are optimized for "Fresh Air" environments. The smaller size of a battery (to get the same energy density) allows for a larger heatsink on the RAID processor, which allows you to keep the card in a hotter environment with less airflow and still stay within temp specification.

Protecting RAID controller cache has been debated in the industry for years, comparing batteries to supercapacitors (supercaps). Dell EMC engineering developed its own Flash Backed Write Cache architecture under the PowerEdge RAID Controller (PERC) brand. The engineering team spent seven months comparing the pros and cons of batteries and supercaps with regard to energy densities and capabilities around size and heat.

There is a big 'myth" that supercaps are infallible and ultimately superior. They are NOT. They fail just like batteries do and they have their own set of challenges. Dell EMC uses batteries due to their higher energy density, reduced physical size, and ability to handle elevated thermal environments in PowerEdge servers

Several customer needs were evaluated during the design phase of the PERC RAID controllers for developing a Li Ion battery pack or a supercap to handle the task of moving cache data into non-volatile flash memory. These design factors included:

- Thermal profile to support Fresh Air data centers
- Maintenance free without impacts to performance as seen in previous controllers
- Discharge capacity over time to support a 3-year warranty in worst-case extreme conditions
- Physical size and location in the server that would allow server development teams to maximize memory and IO density

In addition to customer criteria, several critical design parameters were analyzed and consequently supported the decision to choose a Li Ion battery pack over a Supercap.

Cycles

Supercaps support a high number of charge/discharge cycles when compared to Li Ion battery packs. In the RAID subsystem, supercaps or Li Ion packs are always used as a backup power source. This power source is used only in the case of catastrophic

failures, like an AC power loss, to dump the data cache contents safely from RAM to a non-volatile memory location before the controller powers down completely. Customer data shows that these catastrophic failures for enterprise-level servers are rare, and the advantage of supercap's high charge/discharge cycles is minimal or immaterial in this application.

Energy density and physical size

Energy density in a Li Ion cell is significantly greater than a comparable, capable supercap. Per unit weight, a Li Ion cell stores 30 to 50 times more energy than a supercap:

- Standard supercap: 3 – 5 Wh/kg
- Standard Li Ion cell: 100 – 250 Wh/kg

Because of the significant difference in energy density, coupled with a low maximum output voltage, a Supercap-based power pack design requires multiple Supercaps connected in series and/or in parallel. This increases the physical size of the pack as well as the design complexity. Dell EMC server designs are extremely dense and the system designers did not want to sacrifice valuable space to accommodate multiple mounting points for tethered supercap solutions or to waste power to increase airflow unnecessarily.

Degradation and life estimates

Both Supercaps and Li Ion batteries experience degradation when subjected to higher temperatures in the range of 60°C to 65°C. In general, for every 10°C rise in the ambient temperature, a Supercap's lifetime is reduced by a factor of 2 as compared to a Li Ion battery. When designing a power backup solution for Enterprise-class servers, careful consideration must be given to life expectancy and ambient conditions. The design should have sufficient margin to accommodate degradation over the expected life of the product.

Conclusion

While there are Pros and Cons for batteries versus Supercaps Dell EMC's choice of a Li Ion battery in the PERC RAID controllers took these criteria and more into consideration, and delivered a solution that is maintenance free with well understood technology. In addition, the capability to withstand higher temperatures enables your business to save operational expenses through reduced cooling requirements in your data center. Going chiller-less altogether for your next data center will have a huge impact on capital expenditures, while delivering reduced risk—and helping your organization be greener by reducing its carbon footprint. Dell EMC continues to methodically assess the best back up power source for every generation of PERC.

Warranty

The Li Ion battery pack used in the new generation RAID controllers is designed to support a 3-year warranty in the worst-case conditions of 55°C to 60°C ambient temperature.

PERC batteries

Use industry standard prismatic Li Ion cells with approximately 1.6Wh capacity with Transparent Learn Cycles (TLC) and are integrated directly onto the controller.

Point of Failure

Supercap based power source would require multiple parts connected in series and/or in parallel in order to support the energy requirements of a RAID controller backup solution

Reference: **A Comparison between LI Ion Battery and SuperCap technologies**