



Pick the Right RAID Controller for Your Critical Workloads

Prowess Consulting compared hardware and software RAID arrays on Dell™ PowerEdge™ servers across a variety of scenarios to determine which performed best in each usage.

Many enterprise workloads continue to favor hardware RAID configurations because they provide lower latency, higher input/output operations per second (IOPS), and better rebuild performance under load compared to their software RAID counterparts. Hardware RAID leverages dedicated RAID controllers to offer stable and predictable performance, which is essential in mission-critical environments where consistency and swift recovery are critical. Meanwhile, software RAID configurations have started to gain popularity in smaller-scale setups. Because it utilizes system resources, software RAID can achieve remarkable bandwidth and performance with fewer disks, especially when combined with NVM Express® (NVMe®) drives.

Prowess Consulting investigated the performance of software RAID arrays versus hardware RAID arrays to determine in which circumstances each performed better. This report, sponsored by Dell Technologies, presents detailed results from various tests that we conducted on four similarly configured Dell™ PowerEdge™ R760 servers using both software and hardware RAID arrays under diverse conditions.

Our testing encompassed RAID 5 and RAID 10 configurations on the Red Hat® Enterprise Linux® and Windows Server® operating systems. The metrics we analyzed include IOPS, bandwidth, latency, and rebuild performance across RAID configurations of varying disk counts.

The Results

The results of our testing reveal a significant advantage in IOPS for hardware RAID, with median values up to 281% higher than those observed for software RAID, particularly in larger RAID arrays. This increase in IOPS demonstrates hardware RAID's potential in transaction-heavy scenarios, where rapid input/output (I/O) processing is essential. Similarly, in latency-sensitive applications, hardware RAID consistently outperformed software RAID, achieving median latencies up to 99% lower.

Under degraded conditions, hardware RAID showed distinct advantages in handling I/O operations efficiently, thanks to the use of a Dell™ PowerEdge RAID Controller (PERC) H965i. The system architectures we tested with hardware RAID allowed these configurations to mitigate the performance impact of missing disks, sustaining throughput during failures. In contrast, software RAID encountered limitations, relying on system resources that contributed to inconsistent performance and increased latency during similar conditions.

Highlights of the Test Results

In Prowess Consulting's testing, hardware-based and software-based RAID excelled in different areas:

Up to
281%
higher median
IOPS for
hardware RAID

Up to
99%
lower median
latency for
hardware RAID

Up to
3,521%
higher median
bandwidth for
software RAID

Software RAID, however, exhibited a notable advantage in bandwidth, outperforming hardware RAID by a margin as large as 3,521% in certain two-disk configurations. These substantial bandwidth gains underscore software RAID's suitability for data-intensive operations where low latency is less of a priority. Its reliance on the CPU and direct access to NVMe PCIe® lanes prove advantageous for applications that require high sequential data transfer rates rather than low-latency responses.

While hardware RAID struggled with bandwidth scalability due to fixed controller limitations, software RAID leveraged host system resources to achieve higher throughput. However, as disk counts increased, software RAID's dependence on CPU and memory became more evident, affecting performance stability. This observation points to an optimal use case for software RAID in configurations with fewer disks or in setups with ample CPU resources dedicated to bandwidth-focused tasks.

Performance Under Real-World Conditions

During rebuild operations, hardware RAID demonstrated superior resilience and recovery speeds, with rebuild rates significantly surpassing those of software RAID. In our testing, hardware RAID in eight-disk configurations achieved up to 26,243x faster rebuild performance under load. This efficiency in data recovery is critical for minimizing vulnerability in data-sensitive environments, where rapid restoration after drive failures is paramount to maintaining data integrity.

Another critical aspect that we analyzed was memory usage. In our testing, hardware RAID generally utilized 43–46% less memory than software RAID in both optimal and degraded conditions, thanks to its independent controller cache. Software RAID's reliance on system memory for parity calculations and I/O handling heightened memory demands, which could impact application performance under heavy workloads. For memory-constrained systems, hardware RAID's lower memory consumption makes it a more favorable option.

As part of our testing, we ran HammerDB tests, simulating real-world transactional workloads. This testing further confirmed hardware RAID's performance edge. In RAID 5 configurations, hardware RAID consistently performed faster across optimal, degraded, and rebuild states, with performance increasing proportionally as the simulated workload size (that is, the number of warehouses) increased. Hardware RAID's dedicated controller allowed it to sustain higher new orders per minute (NOPM) values across a broader range of configurations, making it advantageous for environments with demanding workload scalability needs.

Comparative HammerDB Performance: Hardware RAID vs. Software RAID—RAID 5, Four Disks (higher is better)

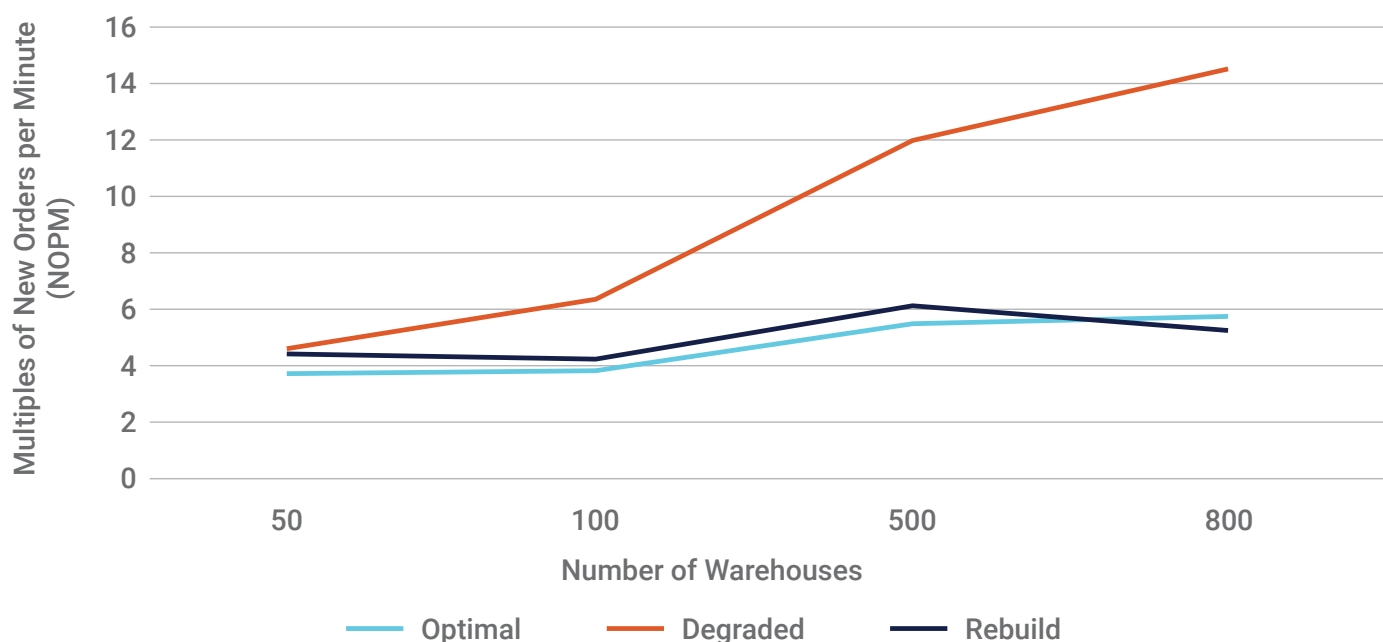


Figure 1 | Comparative HammerDB performance for hardware RAID and software RAID in a RAID 5 configuration with four disks for optimal, degraded, and rebuild disk conditions with 50, 100, 500, and 800 warehouses

Conclusion

Hardware-based RAID excels in performance-critical and large-scale configurations, where its dedicated controllers ensure consistently low latency and efficient rebuilds, even under load. In contrast, software-based RAID proves advantageous in smaller setups, where it leverages system resources to achieve high bandwidth scalability.

Learn More

Get the full story by reading the technical research report, "[A Comparative Study of Hardware and Software RAID Performance and Benefits.](#)"



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