



Comparing Intel® Hardware and Software RAID solutions

Intel offers several types of RAID solutions, ranging from software RAID (aka “host-based RAID”) that resides on Intel® Server Boards to add-in hardware RAID controllers powered by LSI MegaRAID* technology. There are significant architectural differences between these software and hardware RAID solutions that ultimately affect fault tolerance, performance, troubleshooting and price.*

Some of the main architectural differences between software and hardware RAID are:

Software RAID	Hardware RAID
RAID processing performed by host server's CPU	RAID processing performed by dedicated CPU on RAID controller
Manages RAID subsystem at operating system level	Manages RAID subsystem independent from host
Uses host system memory	Dedicated cache memory on controller
No dedicated battery backup	Dedicated battery backup

While software RAID has its place in low-cost storage solutions that require basic reliability, hardware RAID is the preferred solution for applications that require high reliability and availability.

Fault Tolerance

While both software RAID and hardware RAID can tolerate a hard drive failure, only hardware RAID can tolerate a server failure or operating system crash. If a server fails or OS crashes, hardware RAID controllers can protect any data left in the cache with the use of an optional battery backup. When server operation is resumed, the HW RAID controller will finish its disk operations. Unlike HW RAID, software RAID caches its data in the main system memory. Since this memory is not battery backed, data may be corrupted when a server fails or the OS crashes. Some other fault tolerant features that only apply to Hardware RAID are advanced media error detection and correction with Patrol Read and isolation of failing hard drives so that they are not reused.

Troubleshooting Capabilities

Hardware RAID provides better capabilities for problem diagnosis and prevention. With software RAID, there is limited detail in event logs if there is an issue or failure. The information that is provided is only available after the OS boots and may be lost completely if the system or OS crashes. With hardware RAID, events are logged directly into memory on the RAID controller and the detail is much more comprehensive. Event logging is also available before the OS boots and is preserved after a system or OS crash.

Performance

In the past, a primary reason not to use software RAID was because it impacted the overall system performance since it requires the additional CPU cycles to perform RAID operations. But, with today's powerful CPUs, overall software RAID performance can be comparable to hardware RAID for typical benchmarks and in some real-life internal storage solutions.

When comparing write I/O response times (i.e. latency), however, hardware RAID is up to 5 to 100 times quicker than software RAID due to write back caching on hardware RAID controllers. The lower latencies of hardware RAID are very important for streaming applications like video surveillance. Because of the long I/O response times of software RAID, streaming applications pile up data in cache (latency x throughput = cached data). Using software RAID in these applications increases the chance of losing cached data in the event of a server or OS failure.

	Software RAID	Hardware RAID
Small Burst – 50 IOs	0.90 ms	0.17 ms
Large Burst – 200 IOs	13.5 ms	0.17 ms

Example: Comparison of IO Response times (64KB random write single burst - lower is better)



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Advanced Feature Set

The firmware existing on hardware RAID allows for advanced algorithms that are not easily made available for software RAID. These features include RAID 6, revertible hot-spare, advanced array migration or capacity expansion, and higher physical device limits. For many customers, these features alone may result in a preference for hardware RAID; rather than software RAID.

Server Virtualization

When using server virtualization, a hot trend in Enterprise IT, hardware RAID has distinct advantages over software RAID. Server virtualization allows a single server to emulate several smaller (presumably older) servers. Software RAID would require a unique instance of the software RAID stack to be implemented on each virtual server. This could be costly, administratively heavy, and overly complex. Because hardware RAID utilizes a dedicated CPU and on-board cache, and connects to the physical server via the PCI Express bus, I/O requests from virtual servers are considerably less complex.

Usage Model Examples	Main Requirements	Type of RAID	RAID Level	HDD Type
Application server; data stored elsewhere	Basic Reliability	Hw RAID or SW RAID	RAID 1	SATA or SAS
Web/Media-server	Large Capacity with Basic Reliability	Hw RAID or Sw RAID	RAID 5	SATA
Video editing	Large Capacity with Basic Reliability; minimal impact on CPU	Hw RAID	RAID 5/50	SATA
General purpose small business server	Data safety	Hw RAID	RAID 10/ 5	SAS or SATA
Entry-level small business server	Low cost	Hw RAID or SW RAID	RAID 1	SATA
Database-Server, File-Server, Mail-Server	High Availability	Hw RAID	RAID 5/50	SAS or SATA
Database-Server, File-Server, Mail-Server	High Availability and High Performance	Hw RAID	RAID 10	SAS
Video Surveillance	Maximum Throughput & Capacity with High Reliability	Hw RAID	RAID 6/60	SAS or SATA

For the purposes of this paper, all references to software RAID denote Intel® Embedded Server RAID technology II available on all Intel® Server Boards based on Intel Server Chipset S5000. All references to hardware RAID denote Intel® RAID controllers powered by LSI MegaRAID technology.

