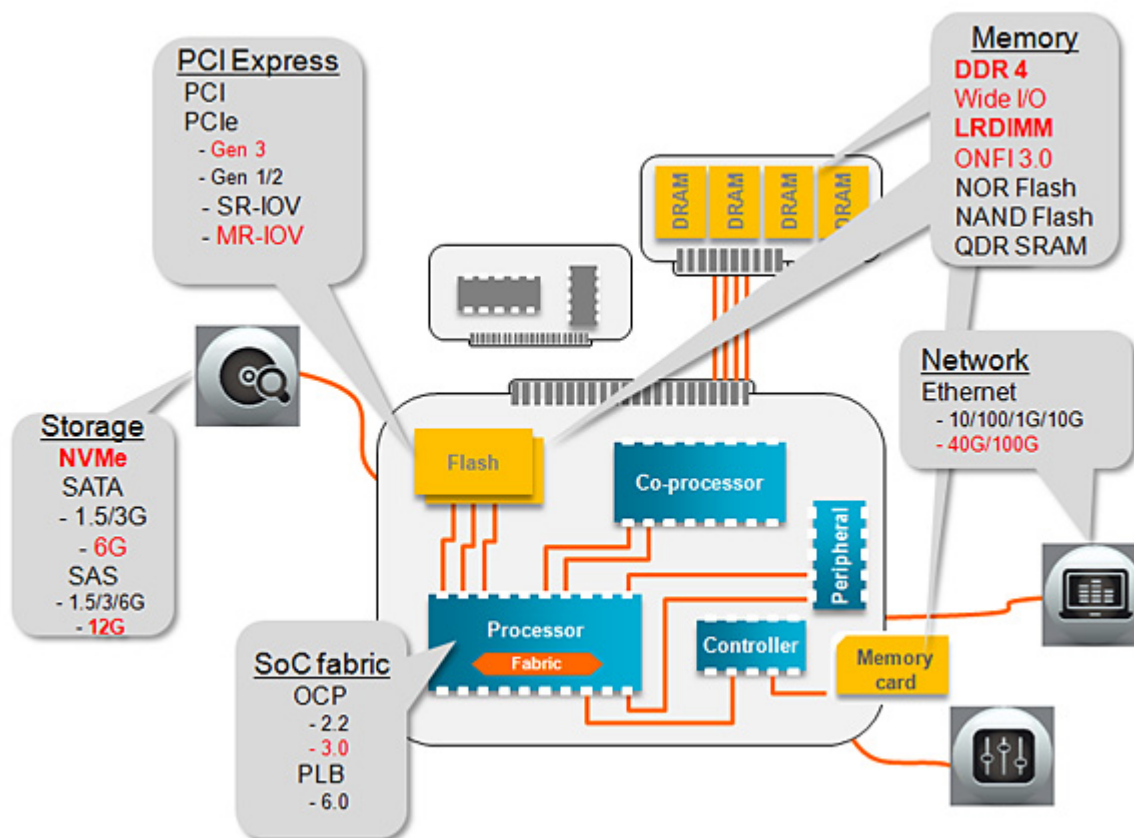


# How NVM Express and 12Gb/s SAS Enable the Cloud – and Why Verification IP Helps

Two emerging protocol storage standards - Non-Volatile Memory Express (NVM Express or NVMe) and 12 Gbit/second Serial Attached SCSI (SAS) - are set to play a crucial role in the future of personal and cloud computing. As a result, Cadence has [announced](#) verification IP (VIP) support for these protocols. Here's some background about the new standards and why they are important.

Both NVM Express and 12Gb/s SAS support high-performance solid state drives (SSDs), enabling both personal computers and enterprise-level servers to move to the faster throughput SSDs allow. To put things in context, however, storage protocols are only one type of standard interface that's needed to support cloud computing. Memory, fabric, and networking protocols are also required. The diagram below provides a broad view of interface standards needed for cloud computing; those marked in red are new within the past 18 months.



In brief, NVM Express is a storage protocol for connecting SSDs and controllers. It will be deployed on the client side with PCs (notebooks, Ultrabooks), but the technology is also expected to move up to the enterprise level. SAS is a protocol for connecting enterprise-level storage systems, and 12Gb/s SAS is its latest iteration, with double the speed of the previous 6Gb/s specification. Both of these new protocols reflect the need to store and quickly move massive amounts of data in and out of the cloud, and a belief that current 6Gb/s SAS and Serial ATA (SATA) protocols are running out of steam for this purpose.

## About NVM Express

The NVM Express specification was released in March 2011 by the NVMe Work Group, whose [web site](#) is a good source of information about the standard. NVM Express 1.0 defines an optimized register interface, command set, and feature set for PCI Express SSDs. Its goal is to provide a scalable interface that unlocks the potential of PCIe-based SSDs now and into the future. NVM Express supports multi-core architectures, and for enterprise class solutions, it supports end-to-end data protection, security and encryption capabilities.

As a whitepaper at the NVMe Work Group site notes, there is an increasing gap in the price/performance of DRAM and hard drives. NVM in the form of SSDs is filling this gap, and PCIe SSDs are being delivered to the market today. PCIe is the highest performance I/O interface available today, delivering 8 GB/s per lane with PCIe Gen3.

According to Tom Hackett, product marketing manager for VIP at Cadence, NVM Express will be "absolutely critical for enabling SSDs in notebook and Ultrabook computers. The PC industry must make that happen to survive, and to keep everybody from just using tablets." He also noted that an emerging enterprise-level standard - SCSI over PCIe, or SOP - is a new competing standard to NVM Express with its own advantages for the enterprise market.

Will the combination of PCIe and NVM Express replace SATA? The jury is still out on that, said Erik Panu, vice president of R&D for the System and Software Realization group at Cadence. "I do expect SATA designs to continue for a while, and I think SATA has a higher layer will exist going forward," he said.

## About 12Gb/s SAS

While your PC today uses a SATA drive, the enterprise world uses SAS drives. According to Hackett, SAS drivers "deliver higher throughput, they are more reliable, and they have system management functions built in. They are a lot more sophisticated [than SATA] and they are also more expensive. SAS is used in the enterprise world for servers just like SATA is used in all consumer PCs."

Another difference between SAS and SATA, he noted, is that SAS is not only used to connect computers to hard drives, but is also used to connect multiple servers to fabrics of switches and storage cabinets. 12Gb/s is needed, Hackett said, because SSDs today are starting to exceed the 6Gb/s bandwidth currently allowed by both SATA and the previous SAS specification.

The SCSI Trade Association promotes SAS and has further information at its [web site](#). A [recent posting](#) notes that 12Gb/s will improve the SAS dollars/gigabit/watt consumed, making it one of the most efficient high-performance interconnect solutions for enterprise storage devices. The article notes that initial adoption is expected in two primary areas: low-latency, high-performance SSDs, and high-performance connectivity that supports tiering and storage build-outs. As 12Gb/s SAS hard disk drives (HDDs) become available, a second wave of adoption will occur.

## Why VIP Matters

So, how will verification IP speed the adoption of these new protocols? NVM Express and 12Gb/s SAS are extremely complex, with complicated data transformations and data routing, Panu said. Data is packaged at different levels of abstraction, making checking very difficult. The storage industry is struggling to adopt both of these new interfaces and verification is a big concern.

"Verification teams typically only start to learn about the new protocols about a month ahead of when they're asked to start coding their testbenches. It's nuts," Hackett said. "How can they go from ground zero to be able to verify one of these complex protocols? They can't do it, they have to have canned expertise. VIP helps people rapidly capture the expertise needed to verify these interfaces, which allows verification teams to ramp up very quickly."

While NVM Express and 12Gb/s SAS are new additions to the [Cadence VIP Catalog](#), Cadence already offers VIP for many other interfaces needed to support cloud computing - including, in fact, all of the interfaces listed in the diagram shown earlier in this post. Cadence offers VIP for over 40 interface protocols and 6,000 memory models.

For a "best practices" guide on how to select and use commercial VIP, [click here](#). A good resource to learn the basics of SSD verification can be found in the "Solid State Drive Verification" presentation on this [web page](#).

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