WHITE PAPER

Seismology Research Accelerated Using Supermicro® SuperServers with Intel® NVMe™ Solid State Drives

NVM Express™ architecture dramatically reduces time required to process data with 6x Bandwidth (IOPS) and 7x lower latency compared to SAS/SATA-based SSDs

"Compared to SAS3 drive on SAS3 HBA, single I/O processing of NVMe™ SSD requires fewer than half the CPU cycles per I/O."

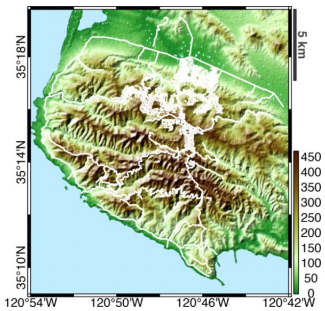

Figure 1. California Seismology Network

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SuperServer Solutions are Optimized with Advanced Acceleration Technologies

Supermicro is transforming science and research with the Green Computing SuperServer® solutions featuring highly advanced acceleration technologies such as hot-swap U.2 NVMe™ SSD, DDR4, 10/40/100 G interconnect along with cooling innovations to deliver exceptional compute performance and high density with minimum power consumption. This advanced range of products enables low total cost of ownership, with optimized solutions for robust scalability you can count on.

Seismology Applications Require a High-Performance Server with High I/O Bandwidth

In an effort to identify earthquake prone areas, Stanford seismologists use sensors to record ambient seismic fields continuously propagating throughout the Earth. As an example, Figure 1 shows the location of a network of 7,000 seismic sensors. While the ocean, weather, and human activities do contribute to ambient seismic fields, it is possible to process the data to reconstruct clear wave propagation. Not only is the reconstruction computationally intensive, the dataset can also be large. In this example, the sensor data over a one-month period exceeded 10 TB.

The key functions of this seismology application can be mapped into system requirements. The cross-correlation function is I/O intensive, and the body and surface wave extraction require large amounts of memory and disk storage.

Additionally other stages, such as imaging and tomography, are compute intensive. For large datasets, bandwidth between disk storage and RAM is the primary bottleneck, making it crucial to minimize latency between levels of the storage hierarchy. Compared to SAS3 drive on a SAS3 HBA, single I/O processing of NVMe™ SSD requires fewer than half the CPU cycles per I/O.

Supermicro® SuperServers enabled with NVMe™ SSDs deliver the Performance Scientific Applications Requirement[1]

Compared against a single SAS3 drive at 220 MB/s, a single NVMe™ SSD outperforms by 12x at 2800 MB/s. Even the maximum theoretical throughput for 8 striped hard drive is still less than a single NVMe SSD. In practice, SAS hard disk drive performance and RAID stack overhead limits throughput of a SAS3 RAID.

For small block access, a single NVMe™ SSD can greatly outperform traditional SAS3 hard drives. A typical single SAS hard drive delivers about 300 IOPS, but a single NVMe™ Intel® Solid State Drive DC P3700 Series delivers 460,000 IOPS; resulting in a 1500x improvement. This is especially important while performing the cross-correlation of the seismic sensor data since there are many small random file reads and writes. While it is possible to preprocess the dataset for more sequential disk access, using an Intel® SSD Data Center Family for NVMe™ drive removes this burden.

Supermicro SuperServers enabled with NVMe™ technology, are flexible and scalable to the storage requirements of I/O intensive workloads, with support for up to 10 NVMe™ drives in a 1U rack form factor and 24 NVMe drives in a 2U rack form factor. With 2TB NVMe™ SSDs, it is possible to achieve 20TB of all-flash storage in 1U rack or 48 TB of NVMe storage in 2U rack.

Experimental Results from an Ultra SuperServer with Optimized NVMe Drives

Figure 2 (left) shows part of the recorded signals. For an initial processing, cross-correlation between all pairs of receivers are computed for the entire time interval (correlation of 7000 times 7000 traces for 1 month). After cross-correlation, clear wave propagation is reconstructed (right). This information is used to estimate the velocity of propagation and thus, the elastic parameters related to the safety of the area for large earthquakes.

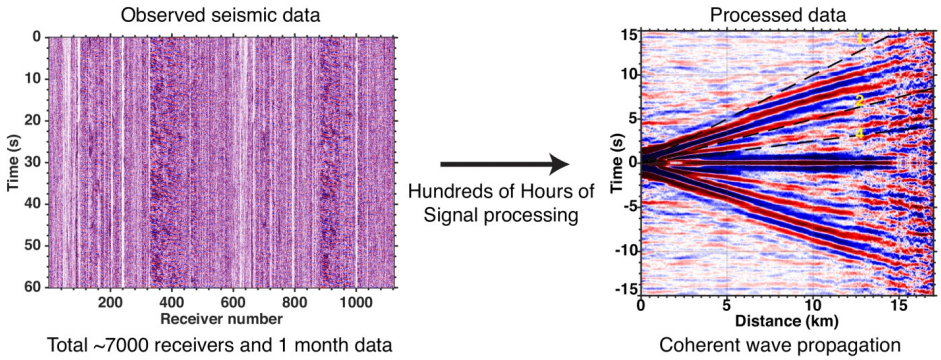

Figure 2. Effects of hundreds of hours of signal processing on observed seismic data.

NVMe™ Optimized SuperServers: Broadest NVMe Product Line in the Industry

Supermicro is driving innovation with the IT industry's broadest range of NVMe server and storage solutions. Rapidly expanding hot-swap NVMe support across the Ultra, TwinPro, FatTwin, WIO, DCO, SuperBlade and storage platforms to accelerate adoption and provide cost effective economies of scale. Combining boot functionality and innovations in cooling and systems management, the systems together with Intel® SSD Data Center Family for NVMe™ offer feature sets that maximize performance, density, efficiency and reliability while lowering overall TCO.

[1] Source: Intel Solid-State Drive DC P3700 Series Product Specification: https://www-ssl.intel.com/content/www/us/en/solid-state-drives/ssd-dc-p3700-spec.html