



Western Digital®

Case Study



Western Digital® and Xinnor® Team up to Power the Cheetah RAID Raptor Platform



Challenge

Provide RAID protection without the performance constraints typically associated with traditional RAID for Edge applications.

Solution

Xinnor xiRAID and Ultrastar DC SN650 NVMe™ SSD drives seamlessly meet Cheetah RAID Raptor platform specifications without compromising performance.

Key Results

The remarkable efficiency of the xiRAID engine adds performance and protection to the Ultrastar DC SN650 NVMe SSD drives to create a powerful storage solution for Edge applications without compromising performance.

Executive Summary

To meet the demanding performance requirements of Edge applications involving sequential operations and multithreaded access for capturing, processing, and storing vital data, it is essential to utilize storage systems that can deliver exceptional performance. These applications encompass various use cases such as video surveillance, streaming, data logging and capturing, autonomous vehicles, and ruggedized storage for industrial and military purposes.

In this document, we will assess the performance of the Western Digital Ultrastar® DC SN650 drives when combined with Xinnor's software RAID on a Cheetah RAID Raptor platform. The goal is to determine whether this integrated solution fulfills the high-performance demands set by these Edge applications.

Test Objectives

- 1. Drive performance (RAW):** Non-RAID raw performance of the Ultrastar DC SN650 NVMe™ drives.
- 2. Drive performance (RAID):** RAID performance using the xiRAID engine to evaluate overhead.
- 3. Filesystem performance:** EXT4 and XFS filesystems performance comparison during sequential write operations to determine which one can process up to 4 streams of uncompressed 4K video.

Test Platform

For our setup, we used the Cheetah RAID Raptor platform populated with 12 Western Digital Ultrastar DC SN650 NVMe™ enterprise SSDs protected by Xinnor's software RAID (xiRAID). The Raptor platform features 3 hot-pluggable cannisters, each of which host 4 drives configured in RAID 5.

Xinnor xiRAID

xiRAID is a software RAID solution designed from the ground up for NVMe performance. It provides a high level of flexibility while keeping host resource utilization to an unprecedented minimum. Specifically designed to handle the high level of parallelism of NVMe devices, xiRAID eliminates the bottleneck caused by 'traditional' RAID controllers and allows delivery of up to 97% of raw device performance.

Ultrastar DC SN650 NVMe SSDs

Ultrastar DC SN650 NVMe SSDs are optimized for cloud and scale-out workloads providing higher QoS consistency and superior storage utilization for object storage as emerging workloads for big data, artificial intelligence and machine learning are increasing in size and complexity.

Cheetah RAID Raptor

Cheetah RAID's Raptor Platform is a powerful and high-performance 2U server that is specifically designed to meet the unique demands of the media and entertainment industry, as well as military and autonomous vehicle applications, even in harsh and challenging environments.

Test Hardware

- **CPU:** AMD™ EPYC™ 7443P 24-Core Processor; Thread(s) per core: 1; Core(s) per socket: 24
- **Motherboard:** Supermicro® H12SSL-i
- **RAM:** Micron® DIMM DDR4 Synchronous Registered (Buffered) 3200 MHz, 256GiB
- **Drives:** 12 * Western Digital Ultrastar DC SN650, 7.68TB1
- **OS:** Oracle® Linux® 8.4, Kernel: Linux 5.4.17-2102.203.6.el8uek.x86_64
- **RAID:** Engine: xiRAID 4.0, Level: 5, Stripe: 128K

Drive Performance (RAW) Non-RAID

Performance tests were conducted on the drives using the FIO utility. Prior to performance tests, preconditioning was carried out using the following FIO pattern:

```
iodepth=16, numjobs=1, rw=write, size=100%, ioengine=libaio, blocksize=128k, direct=1, loops=2
```

Block device tests were conducted on each disk simultaneously using the following FIO pattern:

```
ioengine=libaio, rw=write, bs=1M, iodepth=64, runtime=300, direct=1
```

For sequential write and read operations, the block size was set to 1M.

The test results are as follows:

NVMe	Seq. Write (GB\s)	Seq. Read (GB\s)
nvme0n1	1,98	6,33
nvme1n1	1,95	6,41
nvme2n1	2,02	6,32
nvme3n1	2,02	6,33
nvme4n1	2,01	6,31
nvme5n1	2,02	6,34
nvme6n1	1,97	6,41
nvme7n1	1,96	6,35
nvme8n1	1,98	6,37
nvme9n1	1,95	6,35
nvme10n1	2,03	6,36
nvme11n1	1,98	6,34

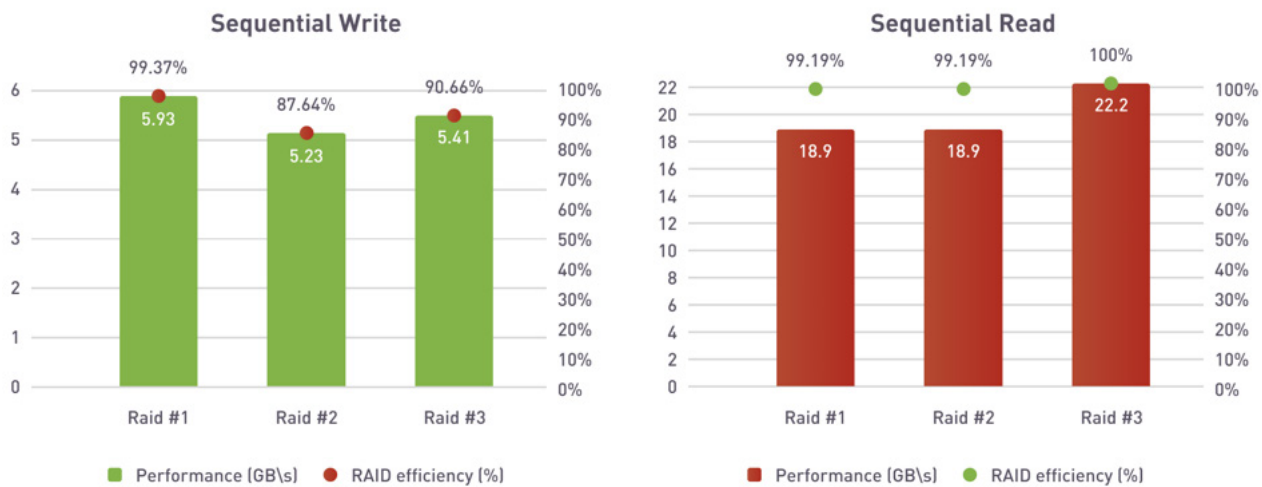
Drive Performance (RAID): Xinnor xiRAID

To test the performance of the xiRAID engine, we created three RAID 5 arrays consisting of 4 disks each. RAID options were tuned as follows:

- Scheduling was enabled, merge was disabled by default.

Tests were conducted using the FIO utility with the same configuration as for the drive tests. Block size was changed to 384K for sequential write tests.

The test results are as follows:



RAID efficiency is calculated as percentage of the theoretical maximum performance considering the RAID 5 impact:

$$\frac{\text{RAID performance}}{\text{Average drive performance} \times (\text{number of drives} - 1)} \times 100\%$$

Filesystem Performance: EXT4 vs XFS

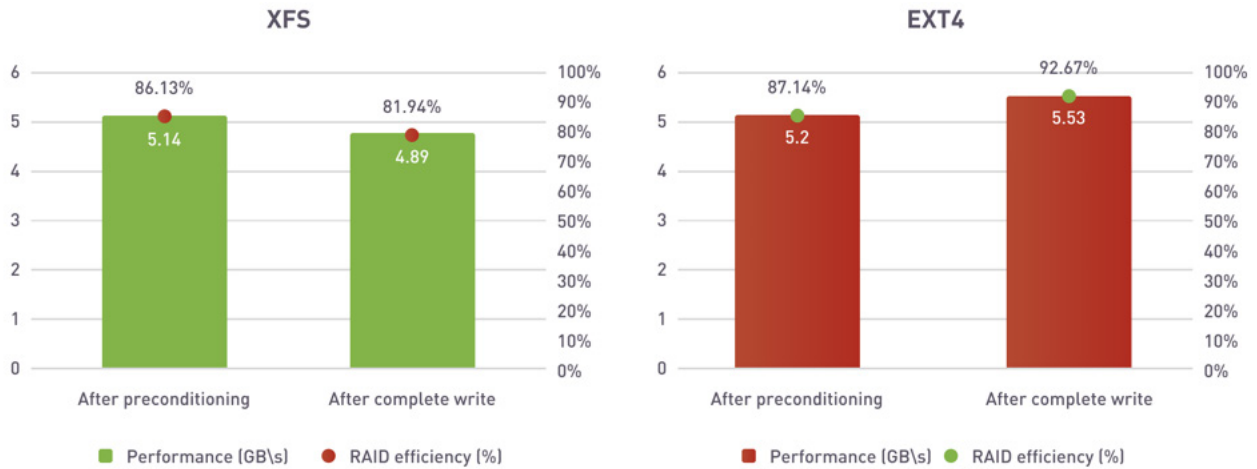
To compare performance on different file systems during sequential write operations, a full-size LUN was created on RAID, formatted to the EXT4 file system and tests were performed. Each test ensured the write operations could provide sufficient performance to process up to four streams of uncompressed 4K video.

Following the preconditioning, RAID was recreated, and the full-size LUN was formatted to the XFS filesystem and tested again.

The following scenario was executed to compare filesystems:

1. Preconditioning of the drives.
2. RAID and volume creation.
3. Testing with frametest.
4. Long frametest run until the drives have been fully written.
5. Repeating the test with frametest.

Frametest parameters were as follows: -w 4k -t 4 -n 9000 (write 4k quality in 4 threads for 9000 frames).



Conclusion

The performance tests conducted on the SN650 NVMe drives have showcased results that are in line with the stated specifications. Furthermore, the tests conducted on the RAID block devices have revealed that the performance of the NVMe drives, when integrated into the RAID array, closely aligns with the combined performance of the individual drives. This indicates the remarkable efficiency of the xiRAID engine. In addition, the volume formatted with the EXT4 filesystem exhibits superior sequential write performance, even after the drives have been fully written. This observation emphasizes the resilient performance of the storage system, even under demanding conditions.

Based on these findings, we can conclude that Western Digital Ultrastar DC SN650 drives protected by Xinnor xiRAID software RAID and operated in Cheetah RAID Raptor platform, deliver sufficient performance to handle up to 4 streams of uncompressed 4k video, meeting the requirements of most Edge applications.

About Western Digital

Western Digital is on a mission to unlock the potential of data by harnessing the possibility to use it. With Flash and HDD franchises, underpinned by advancements in memory technologies, we create breakthrough innovations and powerful data storage solutions that enable the world to actualize its aspirations. Core to our values, we recognize the urgency to combat climate change and have committed to ambitious carbon reduction goals approved by the Science Based Targets initiative. Learn more about Western Digital and the Western Digital, SanDisk® and WD® brands at www.westerndigital.com

About Xinnor

Xinnor is an Israeli-based software development company that specializes in creating innovative data storage solutions. Its main product is xiRAID, a patented software RAID technology that delivers exceptional performance. xiRAID is a product of a decade of math research, unique algorithms of data protection and in-depth knowledge of modern CPU operation. Although it works with all types of storage devices, xiRAID really shines when deployed together with NVMe or NVMe-oF™ devices. xiRAID is the only software solution in the market capable of driving up to 97% of raw device performance in computationally heavy RAID configurations, while maintaining a very modest load on the host CPU and low memory footprint. You can learn about Xinnor at www.xinnor.io.

About Cheetah RAID

Founded in 2006, it has positioned itself as a leader in building high-performance, small form factor NVMe servers for the Media and Entertainment, Autonomous Vehicle markets and US Navy. Its solutions are ideal for use in applications where space is limited, and performance is essential. Cheetah's small form factor NVMe servers are designed to provide high performance and reliability while taking up less space. You can learn about Cheetah Raid Storage at www.cheetahraid.com.

