WARP*raid*

WARP Mechanics offers a variety of enterprise class, ultra-dense RAID building blocks. This allows flexibility in customizing solutions for maximum density, best-in-class performance, or a blend of the two approaches.

If designed for density, the WARP*raid* appliances can scale to 6PB in a single data center rack. If designed for performance, a WARP*raid* rack could deliver over 100 Gigabytes per second of throughput in the same footprint. The choice is yours.

Truly a turnkey solution, all software is pre-configured at the factory. Only site-specific parameters need be configured. Rack the components, cable, and go.

Performance

IO-intensive products use large amounts of pure memory and hybrid NVMe+SSD caches to accelerate HDDs.

These systems deliver industry-leading performance and scalability while maintaining a favorable cost point. Using a cascaded cache to manage DRAM, write-optimized non-volatile RAM, and read-optimized SSD, an appliance can be tuned for the working data set of any customer. Constructed with multiple CPUs and state of the art network connectivity, the WARP Mechanics provides unmatched processing and compute power for the most demanding applications.

WARP appliances can deliver over a million IOPS in just 4U, with advanced features such as clustering, replication, compression, de-duplication, thin provisioning, and snapshots. Solutions include media transcoding, scientific processing, analytics, or any storage performance driven environment.

Density

Capacity-focused appliances offer industry-leading "cost per TB." They are ideally suited for nearline or archive applications, or as primary storage for infrequently-accessed data. A fully configured system can contain more than 6 petabytes in one data center cabinet.

The WARP Mechanics approach uses enterprise hardware and software as its framework, and a more efficient business model to achieve a favorable cost metric. Each appliance is supported by WARP Mechanics and its resellers, so you have a single point of contact for support.

Simplified Management Solution

Like all OEM-class product companies, WARP Mechanics leverages existing software where appropriate. This approach benefits customers through lower pricing, higher reliability, and faster delivery of new features and updates.

The WARP*ware* stack starts out as an enhanced version of CentOS Linux: the leading supercomputing operating system deployed at Lawrence Livermore National Lab, Sandia National Lab, Los Alamos National Lab, and many other top-ranked HPC facilities.

WARP then adds a web-based GUI and a powerful CLI to the tools already included in Linux. The complete management stack is integrated with WARP*nas* hardware and software layers, and the combined turn-key appliance is fully supported by WARP Mechanics.
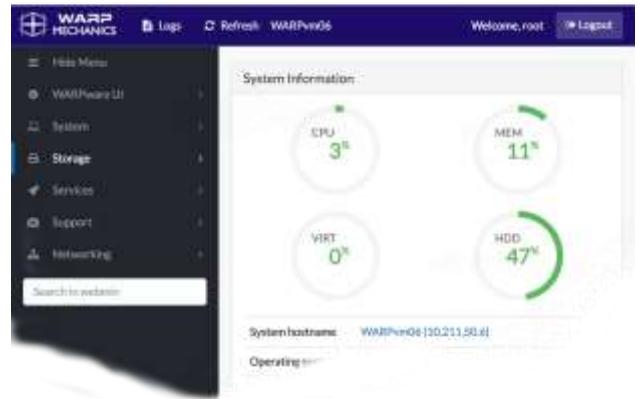
At a lower level, this strategy gives WARP*ware* the benefits of ZFS, which brings scalability, performance, and enterprise storage features.

For instance, WARP*ware* supports effectively **unlimited file system sizes**. It is practical to scale the appliance beyond a petabyte in a single filesystem with current disk densities. Livermore, for example, is running a ~**70 petabyte** filesystem in production using the code.

It also supports virtually **unlimited snapshots**. Many legacy solutions are limited to e.g. 255 snapshots, but WARP*ware* can accommodate 2×10^{48}. Run hourly snapshots if desired, to support extremely granular recover points.

Of particular interest in large configurations, WARP Mechanics has features intended to **silent data corruption.** WARP*ware* provides end-to-end checksums and transactional copy-on-write IO operations. CoW eliminates RAID 'write-holes', and checksums eliminate the silent data corruption that has plagued legacy storage solutions at this scale. This is increasingly important, as individual disk sizes get larger and lower-reliability SATA moves into the Enterprise.

In fact, the software supports too many other features to list in this document: numerous monitoring and reporting tools, iSCSI/iSER/SRP target mode, mirroring and replication for disaster recovery and remote site backups, thin provisioning, upgradability to pNFS or Lustre to provide a global namespace, and more.

For a complete list, or to schedule an evaluation, contact your WARP Mechanics authorized reseller.

Application-Centric Optimization

The WARP Mechanics name is synonymous with ultimate power and performance. However, not all data access needs to take place at those speeds. The goal of the WARP Mechanics appliance portfolio is to allow customers to match the cost to performance ratio appropriate for their specific data sets.

To that end, the archive-optimized appliances use some of the same platforms and software stacks as their counterparts, but are optimized to meet the cost targets of lower activity rate data. In contrast, the performance-optimized systems deliver the highest possible throughput (HDD-based) or IOPS (SSD-based).

The WARP*raid* appliances deliver a truly massive amount of storage for a reasonable price. WARP*raid* is an ideal choice for customers who need:

- Optimal density per:
  - Terabyte of at-rest capacity, or
  - Gigabyte per second of throughput, or
  - I/O operations per second
- Turnkey deployment model
- Simple management interface

WARP 38000 Series Unified Storage Appliances

The **WARP Mechanics 38000** series of storage arrays offer turnkey block-level RAID and/or NAS in a variety of fully integrated configurations of high-capacity spinning-disk HHD, performance specific SSDs, and maximum IO NVMe modules to provide industry-leading performance, scalability and reliability compared to competing arrays. Based on the **WARP Mechanics WDS-9460** platform, three distinct versions have been developed to achieve specialized solutions to specific environments.   All three appliances have the following characteristics:

- Enterprise reliability, availability, & serviceability
- Hot-pluggable drives, I/O controllers, and power / cooling FRUs
- Dual WARP*ware* controllers
- Network interface options up to:
  - 8x 10/40 Gbps Ethernet
  - 4x 40/56 Gbps FDR RDMA IB
  - 4x 100 Gbps EDR RDMA IB
  - 4x 100 Gbps RDMA Omni-Path

WARP 38000-S "StorageMatrix"

The **WARP Mechanics 38000-S** is an ultra-dense storage appliance. It offers a turnkey solution for maximum capacity. The system sets a new cost-to-capacity ratio standard while maintaining compatibility with existing storage infrastructure. It is designed to provide maximum throughput, data integrity, and always-on availability. The WARP Mechanics 38000-S features include:

- Ultra-dense 60x 10TB HDDs per enclosure
- 600TB raw per 4U enclosure
- 450TB usable in dual-parity RAID

WARP 38000-H "HybridMatrix"

The **WARP Mechanics 38000-H** is a turnkey network-attached non-volatile RAM, SSD, and HDD system with industry-leading price, performance, and scalability. This system has a high capacity with accelerated read/write for a balanced capacity and performance to cost ratio. It is an ultra-dense space and power saving solution. This is optimal for large scale IO intensive workloads with high capacity and a relatively small live data set. The WARP Mechanics 38000-H features include:

- 60x 10TB SAS HDD
- 20x high capacity 2TB read optimized SSD modules
- 4x NVMe drives for write cache
- 600TB usable in dual-parity RAID with optimized read and write cache
- IOPS ~500k in cached read and write combinations

WARP 38000-M "MemoryMatrix"

The **WARP Mechanics 38000-M** is a turnkey network-attached non-volatile RAM + SSD system with industry-leading price, performance, and scalability. This system maximizes the IOPS and bandwidth performance for the most demanding applications.

It is an ultra-dense space and power saving solution built on the WDS-2224 JBOD. This is optimal for large-scale IO intensive workloads with large live data sets. The 24x high capacity SSD modules per 2U enclosure are typically configured as two12-disk RAID 6 sets to maximize protection and performance. Or, for write-intensive workloads, include up to four NVMe modules per controller for transparent write acceleration. These RAID sets are added to the overall ZFS storage pool and can be allocated to a nearly limitless number of volumes presented to hosts. This yields 2.2PB of usable RAID protected SSD storage. The WARP Mechanics 38000-M features include:

- Up to 24 high capacity SSD modules per enclosure
- Up to 4 NVMe drives per controller for write cache
- ~144TB usable in dual-parity RAID configuration
- IOPS ~1M in read and write combinations

WARP*raid* Example Architecture

WARP MECHANICS®

The WARP*raid* appliances are constructed using WARP Mechanics hardware platforms, WARP software developed in-house, and WARP-certified pre-integrated software packages.
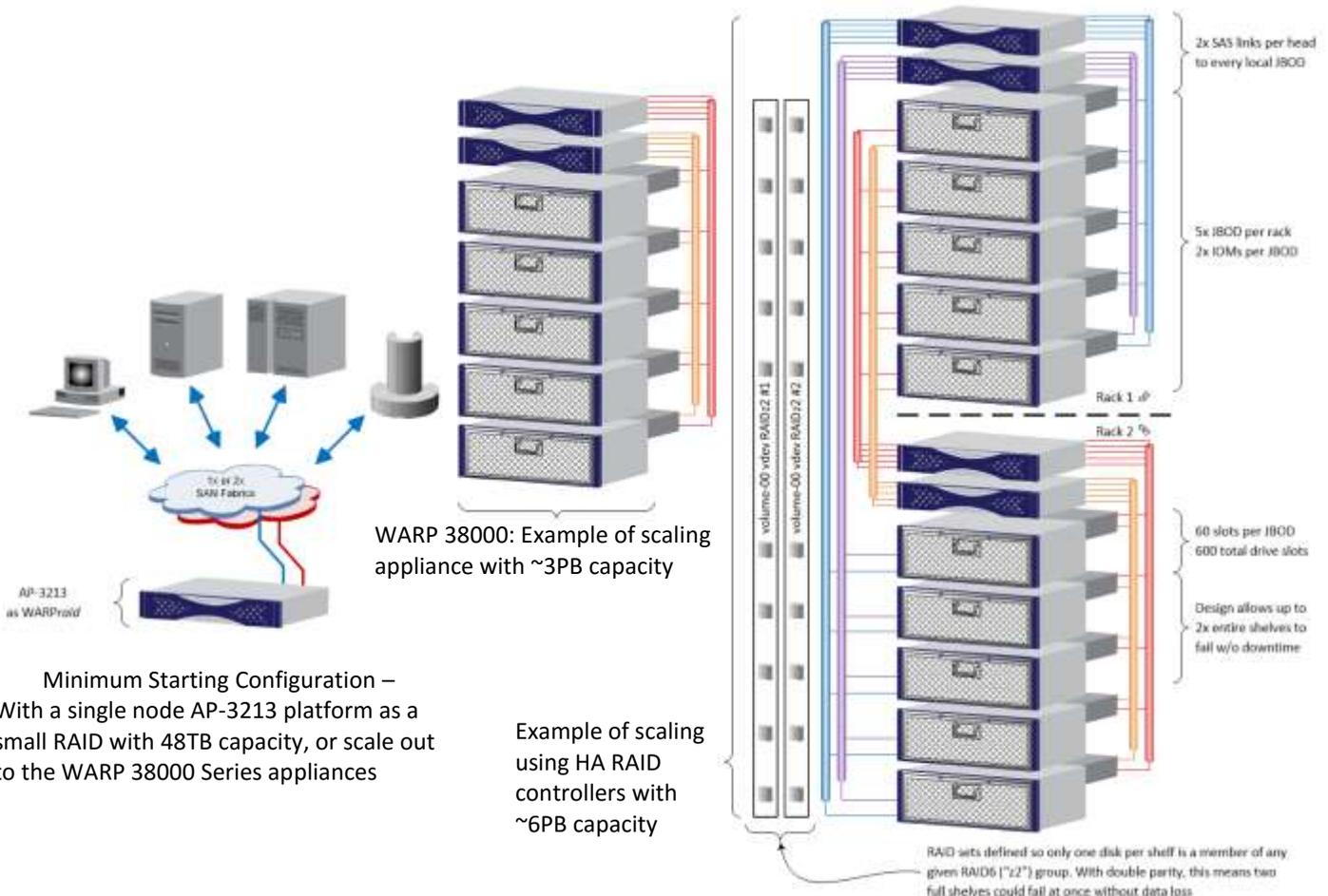
This simplest example of a WARP*raid* solution is to leverage the **WARP Mechanics AP-3213** platform. Starting with a single node chassis with 12 drive bays, the AP-3213 WARP*raid* can take full advantage of the ZFS technology benefits offering up to 48TB of capacity and a full range of connectivity and performance options. This unit may be outfitted with moderate capacity 4TB drives up to high-cap 10TB drives or contain performance enhanced SSDs as part of a cache or storage solution.

WARP*raid* appliances can support more than six petabytes of storage in a single data center rack. In such a configuration, the bulk storage is contained within WARP Mechanics WDS-9460 storage platform; each storage enclosure is factory-configured with up to 60x 10TB drive modules.

A customer can start with an AP head by itself containing SSDs and/or HDDs, or a head connected to a single storage shelf, then scale up as needed. Each storage shelf can hold 600TB of bulk spinning disk storage, with optional SSDs for cache. Each additional shelf adds up to another 600TB of capacity. IO Performance can be increased linearly by adding additional AP head units.

WARP*raid* systems can be combined with WARP*nas* or WARP*fs* to create WARP 38000 and WARP 41000 solutions.

WARP 38000: Example of scaling appliance with ~3PB capacity

Minimum Starting Configuration – With a single node AP-3213 platform as a small RAID with 48TB capacity, or scale out to the WARP 38000 Series appliances

Example of scaling using HA RAID controllers with ~6PB capacity

AP-3213 as WARP*raid*

2x SAS links per head to every local JBOD

5x JBOD per rack
2x IOMs per JBOD

60 slots per JBOD
600 total drive slots

Design allows up to 2x entire shelves to fail w/o downtime

Rack 1

Rack 2

RAID sets defined so only one disk per shelf is a member of any given RAID6 ("z2") group. With double parity, this means two full shelves could fail at once without data loss.