

RAID and storage

Usable capacity, failure tolerance and the assumptions behind the numbers.

Capacity assumptions

N = active disks, excluding hot spares.

S = capacity of the smallest active disk.

Formulas below assume equal effective disk sizes and conventional layouts, before filesystem, controller and reserved-space overhead.

Common RAID levels

RAID 0: $N \times S$. No disk-failure tolerance.

RAID 1: S for a two-disk mirror. One disk can fail.

RAID 5: $(N-1) \times S$. At least three disks; any one disk can fail.

RAID 6: $(N-2) \times S$. At least four disks; any two disks can fail.

RAID 10: $(N/2) \times S$ for mirrored pairs. At least four disks, even N . One failure per pair can be tolerated; losing both disks of a pair loses the array.

Nested parity arrays

With **G** equal-size groups:

RAID 50: $(N-G) \times S$; at least three disks per group; one failure per group.

RAID 60: $(N-2G) \times S$; at least four disks per group; two failures per group.

Failures must stay within each group tolerance.

Controller support varies.

Worked example

Six active 8 TB disks in RAID 6:

$(6-2) \times 8 \text{ TB} = \mathbf{32 \text{ TB}}$, approximately **29.10 TiB**, before overhead. A separate hot spare adds no usable capacity.

TB and TiB are different

1 TB = 1,000,000,000,000 bytes.

1 TiB = 1,099,511,627,776 bytes.

Divide decimal TB by about 1.0995 to estimate TiB. A lower displayed binary number is not automatically missing capacity.

Spares and rebuilds

A hot spare waits to replace a failed disk; it is not extra parity or a backup. Rebuilds can take substantial time and reduce performance. Remaining disks are still exposed to additional failures and read errors. Monitor rebuild progress and backups together.

Provisioning terminology

Raw: total device capacity.

Usable: capacity after redundancy and relevant overhead.

Allocated / provisioned: capacity assigned to workloads.

Used: data currently consumed.

Thin provisioning: logical allocations can exceed physical capacity; monitor actual free space and growth.

Plan the workload, not just capacity

Consider latency, IOPS, throughput, write patterns, controller/cache protection, failure domains and expansion options. Compression and deduplication depend on the data. Storage pools, erasure coding and vendor-specific layouts can follow different rules.

RAID is not a backup

Redundancy can preserve service through certain disk failures. It does not provide independent recovery from deletion, ransomware, corruption or loss of the entire array. Keep and test separate backups.