1 OceanStor Dorado V3 Capacity Calculation Algorithm

1.1 Available Nominal Capacity of a Single Disk

Available nominal capacity of a single disk = Nominal capacity of a single disk – (512 MiB + 65 MiB) – IF(Coffer disk, 5 GiB, 0)

512 MiB and 65 MiB are reserved for disk authentication (512 MiB is the main reservation and 65 MiB is for backup). In addition, 5 GiB is reserved on each of the first four disks of each controller enclosure for coffer space.

1.2 Usable Capacity

Usable capacity = [Total available nominal capacity of single disks x (1 – Reserved capacity proportion) x (1 + Compensation capacity proportion) – Hot spare capacity] x RAID utilization

1.3 Reserved Capacity Proportion

The reserved capacity proportion includes garbage collection and metadata ratios. The specific value depends on the disk type.

Nominal Capacity of a Single Disk (GB)	Disk Type	Reserved Capacity Proportion
600	SAS	15.2%
900	SAS	15.2%
1800	SAS	15.2%
3600	SAS	15.2%
960	SAS	20.5%
1920	SAS	20.5%
3840	SAS	20.5%
7680	SAS	20.5%
15360	SAS	20.5%
30720	SAS	20.5%

Nominal Capacity of a Single Disk (GB)	Disk Type	Reserved Capacity Proportion
800	SAS	20.5%
1600	SAS	20.5%
3200	SAS	20.5%
960	NVMe	20.5%
1920	NVMe	20.5%
3840	NVMe	20.5%
7680	NVMe	20.5%
15360	NVMe	20.5%
1000	NVMe	23.68%
2000	NVMe	23.68%
4000	NVMe	23.68%

1.4 RAID Utilization

RAID utilization = (Total number of RAID columns – Number of RAID parity columns M)/Total number of RAID columns

$$\text{Total number of RAID columns} = \text{MIN}\left(\text{Disk quantity} - \begin{cases} 3 & \text{Disk quantity} >= 26 \\ 2 & 25 >= \text{Disk quantity} >= 13 \\ 1 & 12 >= \text{Disk quantity} \end{cases}, \quad 25\right)$$

Number of RAID parity columns M:

RAID Type	Number of RAID Parity Columns M
RAID 5	1
RAID 6	2
RAID-TP	3

1.5 Compensation Capacity Proportion

Rules:

Software version V300R001:

1. For old hardware (Ivy Bridge), capacity compensation is not performed.
2. For new hardware (Purley), if the disk quantity is ≥ 15, 6.55% is compensated for the usable capacity.

Software version V300R002:

3. For old hardware (Ivy Bridge), if the disk type is SAS, capacity compensation is not performed. If the disk type is NVMe and disk quantity is ≥ 15, 3.93% is compensated for the usable capacity of multi-stream disks; non-multi-stream disks are not compensated.
4. For new hardware (Purley), if the disk quantity is ≥ 15, 10.62% is compensated for the usable capacity of multi-stream disks and 6.55% is compensated for the usable capacity of non-multi-stream disks.

1.6 Hot Spare Disk Quantity

The hot spare disk quantity depends on the software version, number of disks, and hot spare policy.

Software versions V300R001 and V300R002C00:

Disk Quantity	Hot Spare Disk Quantity (High Hot Spare Policy)	Hot Spare Disk Quantity (Low Hot Spare Policy)
[8, 12]	1	1
(12, 25]	2	1
(25, 50]	3	2
(50, 75]	4	2
(75, 125]	5	3
(125, 175]	6	3
(175, 275]	7	4
(275, 375]	8	4

Software version V300R002C10:

Disk Quantity	Hot Spare Disk Quantity (High Hot Spare Policy)	Hot Spare Disk Quantity (Low Hot Spare Policy)
[8, 12]	1	1
(12, 25]	2	1
(25, 75]	3	2
(75, 375]	3	3

1.7 Hot Spare Capacity

Hot spare capacity = [Hot spare disk quantity x Available nominal capacity of a single disk x (1 – Reserved capacity proportion) + Truncation capacity] x (1 + Compensation capacity proportion)

The truncation capacity depends on the disk quantity and hot spare policy.

Hot Spare Policy	Disk Quantity	Truncation Capacity
High	< 29	(Disk quantity – 4 – Hot spare disk quantity) x 5 GiB x (1 – Reserved capacity proportion)
	≥ 29	0
Low	< 13	(Disk quantity – 4 – Hot spare disk quantity) x 5 GiB x (1 – Reserved capacity proportion)
	≥ 13	0
None	N/A	0

1.8 Raw Capacity

Raw capacity = Raw capacity of a single disk x Disk quantity – Coffer capacity

Example 1: New hardware, dual controllers, 30 SAS SSDs, 3840 GB nominal capacity per SSD, high hot spare policy, RAID 6, software version V300R001

1. Available nominal capacity of a single disk

   Available nominal capacity of a single disk = (3840 GB x 1000 x 1000 x 1000/1024/1024) – 512 MiB – 65 MiB = 3661532.375 MiB = 3575.715209 GiB

2. RAID utilization

   Total number of RAID columns = MIN(Disk quantity – IF(Disk quantity ≥ 26,3,IF(Disk quantity ≥ 13, 2, 1)),25) = 25

   RAID utilization = (Total number of RAID columns – Number of RAID parity columns M)/Total number of RAID columns = (25 – 2)/25

3. Hot spare capacity

   Hot spare capacity = Hot spare disk quantity x Available nominal capacity of a single disk x (1 – Reserved capacity proportion) x (1 + Compensation capacity proportion)

   = 3 x 3575.715209 x (1 – 20.5%) x (1 + 6.55%) = 9086.670064 GiB = 8.87 TiB

4. Usable capacity

   Usable capacity = [Total available nominal capacity of single disks x (1 – Reserved capacity proportion) x (1 + Compensation capacity proportion) – Hot spare capacity] x RAID utilization = [(3575.715209 x 30 – 20) x (1 –20.5%) x (1 + 6.55%) – (3575.715209 x 3) x (1 - 20.5%) x (1 + 6.55%)] x (25 – 2)/25 = 75222.041996 GiB = 73.45 TiB

5. Raw capacity

   Raw capacity = Raw capacity of a single disk x Disk quantity – Coffer capacity = 3575.715209 x 30 – 20 = 107251.45627 GiB= 104.73 TiB

Example 2: Old hardware (new hardware does not support NVMe SSDs), dual controllers, 25 NVMe SSDs, 960 GB nominal capacity per SSD, high hot spare policy, RAID 6, software version V300R001

6. Available nominal capacity of a single disk

   Available nominal capacity of a single disk = (960 GB x 1000 x 1000 x 1000/1024/1024) – 512 MiB – 65 MiB = 914950.34375 MiB = 893.506195 GiB

7. RAID utilization

   Total number of RAID columns = MIN(Disk quantity – IF(Disk quantity ≥ 26,3,IF(Disk quantity ≥ 13, 2, 1)),25) = 23

   RAID utilization = (Total number of RAID columns – Number of RAID parity columns M)/Total number of RAID columns = (23 – 2)/23

8. Hot spare capacity

   Truncation capacity = (Disk quantity – 4 – Hot spare disk quantity) x 5 GiB x (1 – Reserved capacity proportion) = (25 – 4 – 2) x 5 GiB x (1 – 20.5%) = 75.525 GiB

   Hot spare capacity = [Hot spare disk quantity x Available nominal capacity of a single disk x (1 – Reserved capacity proportion) + Truncation capacity] x (1 + Compensation capacity proportion) = [(2 x 893.506195 x (1 – 20.5%) + 75.525] x (1 + 0%) = 1496.19985 GiB = 1.46 TiB

9. Usable capacity

   Usable capacity = [Total available nominal capacity of single disks x (1 – Reserved capacity proportion) x (1 + Compensation capacity proportion) – Hot spare capacity] x RAID utilization = [(893.506195 x 25 – 20) x (1 – 0.205) x (1 + 0%) – 1496.19985] x (23 – 2)/23 = 14833.610925 GiB = 14.48 TiB

10. Raw capacity

    Raw capacity = Raw capacity of a single disk x Disk quantity – Coffer capacity = 893.506195 x 25 – 20 = 22317.654875 GiB = 21.79 TiB

2 OceanStor Dorado V6 Capacity Calculation Algorithm

2.1 Available Nominal Capacity of a Single Disk

Available nominal capacity of a single disk = Nominal capacity of a single disk – (512 MiB + 65 MiB) – 2 GiB

512 MiB and 65 MiB are reserved for disk authentication (512 MiB is the main reservation and 65 MiB is for backup). In addition, 2 GiB is reserved on each disk for coffer space.

2.2 Usable Capacity

Usable capacity = [Total available nominal capacity of single disks x (1 – Reserved capacity proportion) x (1 + Compensation capacity proportion) – Hot spare capacity] x RAID utilization

2.3 Reserved Capacity Proportion

The reserved capacity proportion includes garbage collection and metadata ratios. The specific value depends on the disk type.

Nominal Capacity of a Single Disk (GB)	Disk Type	Reserved Capacity Proportion
600	SAS	15.2%
900	SAS	15.2%
1800	SAS	15.2%
3600	SAS	15.2%
960	SAS	20.5%
1920	SAS	20.5%
3840	SAS	20.5%
7680	SAS	20.5%
15360	SAS	20.5%
30720	SAS	20.5%
800	SAS	20.5%
1600	SAS	20.5%

Nominal Capacity of a Single Disk (GB)	Disk Type	Reserved Capacity Proportion
3200	SAS	20.5%
960	NVMe	20.5%
1920	NVMe	20.5%
3840	NVMe	20.5%
7680	NVMe	20.5%
15360	NVMe	20.5%
1000	NVMe	23.68%
2000	NVMe	23.68%
4000	NVMe	23.68%

2.4 RAID Utilization

RAID utilization = (Total number of RAID columns – Number of RAID parity columns M)/Total number of RAID columns

Total number of RAID columns = MIN(Disk quantity – IF(Hot spare disk quantity = 0,1,Hot spare disk quantity),N)

N：

RAID Type \ Product	Entry-Level	Middrange & High-End
RAID 5	15	12
RAID 6	25	25
RAID-TP	25	25

Number of RAID parity columns M:

RAID Type	Number of RAID Parity Columns M
RAID 5	1
RAID 6	2
RAID-TP	3

2.5 Compensation Capacity Proportion

Rules:

Capacity compensation has two grades:

- Threshold 1 (cap1): 6 TiB. The compensation ratio is 14.6% (ratio 1).
- Threshold 2 (cap2): 20 TiB. The compensation ratio is 2% (ratio 2).

If the total usable capacity excluded by the reservation ratio is totalCap, totalCap = Total available nominal capacity of single disks x (1 – Reservation ratio)

- If totalCap > cap1, calculate the compensation capacity in phase 1: compensateCap1 = (totalCap – cap1) x Ratio 1
- If totalCap > cap2, calculate the compensation capacity in phase 2: compensateCap2 = (totalCap – cap2) x Ratio 2

Calculate the average capacity compensation ratio: averageRatio = (compensateCap1 + compensateCap2) / totalCap

2.6 Hot Spare Disk Quantity

Hot spare disk quantity ranges from 0 to 8.

Constraints: Number of disks – Hot spare disk quantity ≥ 5 (minimum number of RAID columns)

2.7 Hot Spare Capacity

Hot spare capacity = [Hot spare disk quantity x Available nominal capacity of a single disk x (1 – Reserved capacity proportion)] x (1 + Compensation capacity proportion)

2.8 Effective Capacity

Effective capacity = Usable capacity x Data reduction ratio

Example 1: Dual controllers, 30 SAS SSDs, 3840 GB nominal capacity per SSD, 1 hot spare SSD, RAID 6, data reduction ratio 2:1

1. Available nominal capacity of a single disk

   Available nominal capacity of a single disk = (3840 GB x 1000 x 1000 x 1000/1024/1024) – 512 MiB – 65 MiB – 2 GiB = 3659484.375 MiB = 3573.715209 GiB

2. RAID utilization

   Total number of RAID columns = MIN(Disk quantity – IF(Hot spare disk quantity = 0,1,Hot spare disk quantity),25)

RAID utilization = (Total number of RAID columns – Number of RAID parity columns M)/Total number of RAID columns = (25 – 2)/25

3. Compensation capacity proportion

   totalCap = 30 x 3573.715209 x (1 – 20.5%) = 85233.10773465 GiB

   compensateCap1 = totalCap – 6 TiB = (85233.10773465 GiB – 6144 GiB) x 14.6% = 11547.0097292589 GiB

   compensateCap2 = totalCap – 20 TiB = (85233.10773465 GiB – 20480 GiB) x 2% = 1295.062154693 GiB

   averageRatio = (compensateCap1 + compensateCap2)/totalCap = (11547.0097292589 GiB + 1295.062154693 GiB)/85233.10773465 GiB = 15.06%

4. Hot spare capacity

   Hot spare capacity = Hot spare disk quantity x Available nominal capacity of a single disk x (1 – Reserved capacity proportion) x (1 + Compensation capacity proportion) = 1 x 3573.715209 x (1 – 20.5%) x (1 + 15.06%) = 3268.973791982943 GiB = 3.192 TiB

5. Usable capacity

   Usable capacity = [Total available nominal capacity of single disks x (1 – Reserved capacity proportion) x (1 + Compensation capacity proportion) – Hot spare capacity] x RAID utilization = [(3573.715209 x 30) x (1 – 20.5%) x (1 + 15.06%) – (3573.715209 x 1) x (1 – 20.5%) x (1 + 15.06%)] x (25 – 2)/25 = 87216.22077010492 GiB = 85.172 TiB

6. Effective capacity

   Effective capacity = Usable capacity x Data reduction ratio = 85.172 x 2 = 170.344 TiB