For Data Centers

Over-provisioning

Maximize the lifetime and performance of your SSD with small effect to earn more

Application note

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Over-provisioning

1. What is over-provisioning (OP)?

OP is the technology that assigns a certain portion of the SSD's capacity exclusively to the controller to allow the solid-state drive (SSD) to perform Garbage Collection (GC) more efficiently, helping to maintain steady state performance (sustained performance) and extend the SSD's endurance and lifetime.

The ratio of OP is calculated in percentages by dividing the OP capacity by the user capacity. For example, in a total 512 GB SSD, if the OP is 112 GB and the user space is 400 GB, then its OP ratio is 28% (112 GB / 400 GB).

In addition to the benefits of OP, this technology reduces user accessible space. Therefore, under a light workload in a client PC application, users don't need to set additional OP space. However, under a heavy workload (for example, a server, data center or heavy workload client PC applications), a minimum of 6.7% OP is recommended and over 20% and even 50% is being used. Different OP ratios are recommended depending upon usage applications and the workload.

One might wonder why the recommendations should be variable. Data access patterns are the determining factor. Activities that produce frequent read/write requests, especially random read/writes, put extra stress on the SSD, which in turn increases write amplification (a phenomenon by which physical NAND writes outnumber logical write requests from the host).

2. Why is OP important?

OP has a direct effect on the SSD's random performance as the drive is filled with data. Guaranteeing free space to accomplish the NAND management tasks (GC, wear-leveling, bad block management) means the SSD does not have to waste time preparing space on demand, a process that requires additional time as data is copied, erased and recopied. An added benefit is that OP makes all of the SSD maintenance procedures more efficient, reducing the Write Amplification Factor (WAF) by ensuring there's room to work, which improves the SSD's lifetime.

The below table is from internal test results that show the benefits of OP in performance and lifetime.

[Table. 1] Sustained performance and lifetime comparison by OP ratio (4 KB random write)

OP ratio	Sustained performance (4 KB random write)	Lifetime (4 KB random write)
0% OP (512 GB)	7 K IOPS	1
6.7% OP (480 GB)	13 K IOPS	X 2.09 ↑
28% OP (400 GB)	27 K IOPS	X 5.22 ↑

This test is based on internal test results that can vary depending on the test environment.

3. How do I set OP?

Depending on the SSD product, some are already over-provisioned by the manufacturer and users cannot access and control it. However, users can set additional OP areas using several methods - using utility tools (hdparm, etc.), setting unallocated partitions on the operating system (OS) and using Samsung Magician software (SW).

4. Samsung SSDs for data centers are

Samsung 845DC PRO and 845DC EVO SSDs for data centers set aside a permanent amount of OP. This minimum amount of OP is not user configurable.

Samsung SSD for data center	Capacity	OP ratio
845DC PRO	400/800 GB	28%
845DC EVO	240/480/960 GB	6.7%

However, there is no "right" amount of OP to set aside, and it is best to vary it by capacity and situation. And Samsung and other utility tools are providing simple ways to set OP by allocating additional OP space based on user choice.

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