Over-Provisioning Micron Client SSDs Using Storage Executive Software for Microsoft Windows

Overview

SSDs targeted for desktop and notebook computing applications tend to have minimal amounts of native over-provisioning (OP), which can hinder performance in some heavy workloads. This technical brief covers the basics of OP as well as how to adjust the OP of Micron's client SSDs using our Storage Executive desktop application for Microsoft Windows operating systems to help to ensure optimal SSD performance.

The Basics of OP

All flash-based SSDs contain some level of OP, which is spare NAND capacity that is inaccessible to the user or the operating system and that the drive firmware may use to optimize internal processes (for example, background operations like garbage collection and wear-leveling). Because the typical desktop or notebook SSD does not face heavy and sustained workloads, and because desktop computer users do not typically run their SSDs at 100 percent capacity, these SSDs are equipped with minimal native OP — usually around six or seven percent.

As stored (static) data on the SSD nears full

capacity, the SSD firmware has only the native OP left with which to manage these important background operations. This can result in slower SSD performance and an increase in the rate of wear.

Particularly for desktop applications like Windows operating systems, the solution to this capacity problem can be as simple as deleting old or unused files, always leaving about 10 to 15 percent of unused space — especially if the ongoing daily workload is write-intensive, ingesting a lot of new data from the host computer.

More advanced methods of providing additional OP include:

» Making a low-level change to the drive, which reduces the maximum logical block address (MaxLBA). See Micron's Technical Brief: "Over-Provisioning the M600 SSD For Data Center Applications" for more information.

» Changing the size of the SSD's working partitions, which can be performed using Micron's Storage Executive software (version 3.24 and later), as described in this brief.
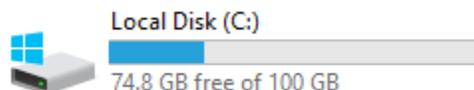
Figure 1: Drive capacity indicator in Windows for a 10 percent over-provisioned 120GB SSD

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Restrictions on OP Capabilities Using Storage Executive Software for Windows

Micron's Storage Executive software (version 3.24 and later) can be used to modify partitions on a Micron client SSD to reserve additional space for OP, with the following restrictions:

» Storage Executive software for Windows 7, 8, 8.1 and 10 support this feature while Storage Executive software for Linux currently does not.

» This feature only works on the last accessible partition created. For a normal Windows installation, this is the C: drive.

» This feature supports only the NTFS file system format.

» TCG-enabled encrypted SSDs are excluded.

» USB-attached SSDs are excluded.

» Any dynamic partitions are excluded.

» If a drive is in write protect mode, is security-locked, or has BitLocker enabled, this feature is not supported.

Modifying SSD Partitions With Storage Executive Software

Note: This section gives a high-level overview of modifying Micron's client SSD partitions with Storage Executive software. Refer to Micron's Storage Executive Software User Guide for detailed instructions.

Viewing Current OP Settings

» When the OP option is available for the SSD, the Over Provisioning menu displays in the left column options bar, as shown in Figure 2.

Figure 2: New Over Provisioning menu option in Storage Executive
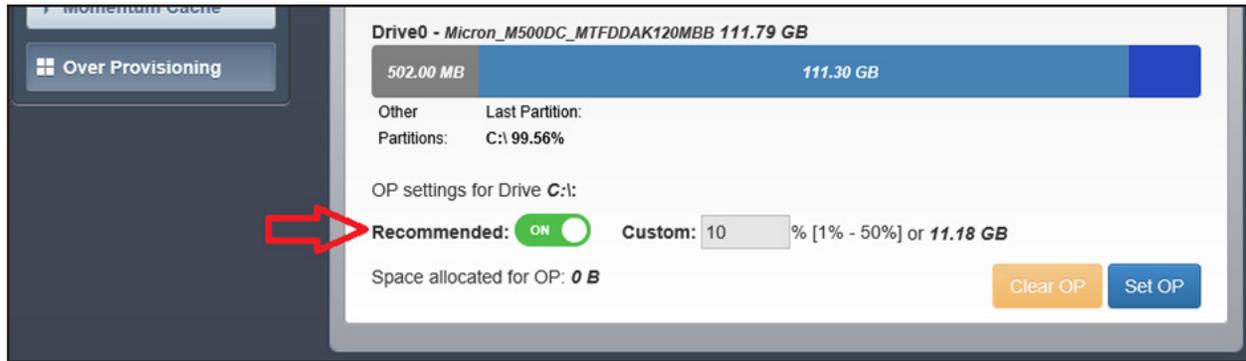
*Figure 3: Recommended OP level of 10 percent and drive capacity indicator (blue bar)
in Storage Executive*

» After clicking the Over Provisioning menu, the current drive capacity indicator displays along with the current OP settings, as shown in Figure 3.

  o The OP level is shown in dark blue on the right side of the drive capacity indicator.

  o By default, Storage Executive software provides a recommended OP level of 10 percent.

Customizing OP Settings

For most desktop operations, setting aside 10 percent of the user area for OP is sufficient to enable the SSD firmware to efficiently manage most workloads. However, if the SSD is nearly full, and the workload includes heavy downloads and file-saves initiated by either the user, running applications, or the operating system, more OP may be needed. When the drive capacity indicator in Windows (as shown in Figure 5) for the drive in question turns from blue to red, the drive is full enough that performance may be impaired.

A custom OP level may be set by ensuring the button next to **Recommended** displays **OFF** in gray. The user can then enter a value between **1** and **50** (percent) in the **Custom** field (shown in Figure 4); however, Storage Executive software prevents an OP setting greater than the actual free space on the SSD from being set. For example, if the working partition is 75 percent full, any OP setting greater than 25 percent is not allowed.
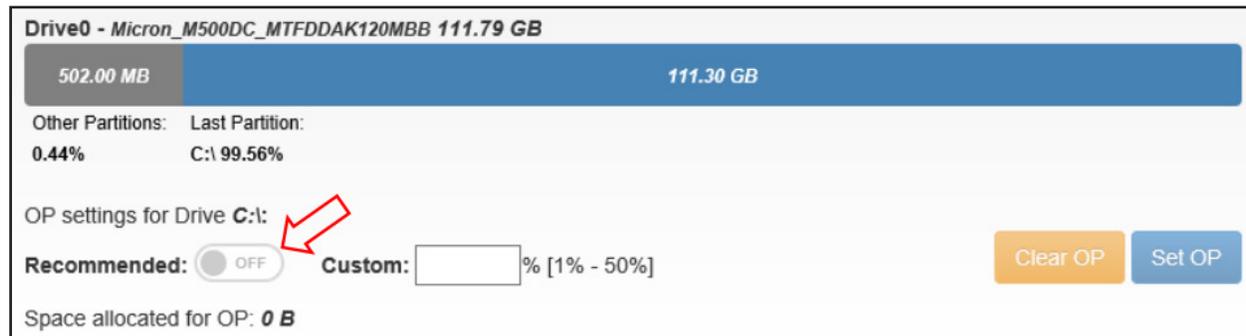
Figure 4: Customizing OP settings and drive capacity indicator in Storage Executive

Beyond Micron's recommended 10 percent OP level for a typical user, we cannot make recommendations for OP settings for heavier workloads. In desktop and notebook computing, the variability in workload from user to user is very high. On the other hand, Storage Executive software's OP feature is flexible, so if adjustments are needed over time, changing the amount of OP is easy.

For example, a default OP of 10 percent may be set when the drive is relatively empty in anticipation of the drive being full in the future. If time passes, and the drive is not full as anticipated, the OP may be easily returned to default, freeing up more space for any instantaneous needs for more capacity. In most notebook/desktop applications, even 10 percent OP is probably not necessary because having 10 percent of empty space in the active partition has the same effect. On the other hand, if the I/O stream is very constant (24/7) and includes significant random, small-block (around 4KB or smaller) write transfers, then an OP larger than 10 percent may be needed, which can be easily updated by the user.
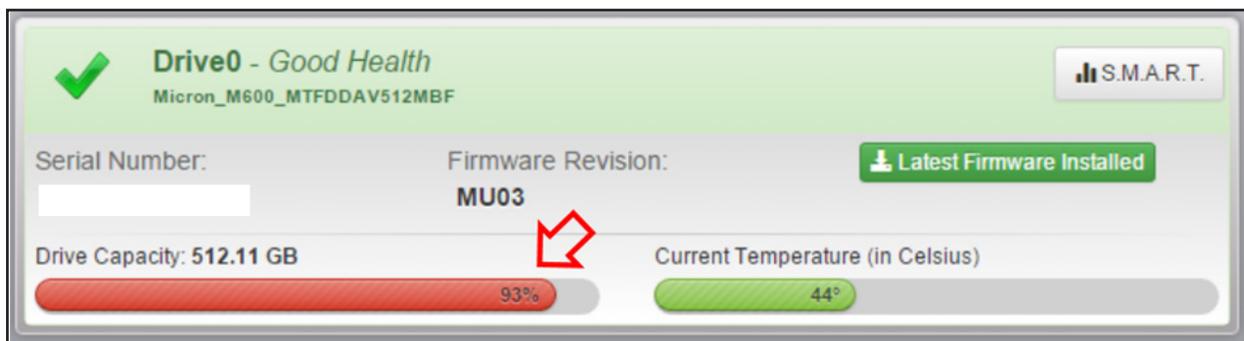
Figure 5: 512GB SSD with >90% capacity used shown in Storage Executive
Note: When the blue bar turns red as shown in Figure 5, and the condition is chronic, additional OP may help performance.

Using Storage Executive Software to Help With the OP Decision

Storage Executive software includes tools that can help determine the optimal OP settings for an SSD. Specifically, Micron's client SSDs enable the user to monitor the drive's write amplification. Write amplification is an attribute common to all SSDs that indicates the ratio of the total number of writes performed internal to the SSD vs.the total amount of data written by the host computer. Write amplification is denoted by the write amplification factor (WAF). See Micron's Technical Note: "Calculating the Write Amplification Factor" (TN-FD-23) for a detailed description on how to calculate the WAF for Micron's SSD. Some recommendations for this calculation in relation to OP are as follows:

» WAF can vary significantly instantaneously, so Micron recommends measuring WAF over several days under a typical system workload.

» A WAF of 1.0 is theoretically perfect, but very rarely achieved. A WAF in the low single digits is generally acceptable.

» If a WAF is higher than single digits, and the SSD is nearly full consistently, setting aside some space for OP is recommended to improve performance and reduce wear.

» Storage Executive software can be used to monitor WAF, change the OP, and then re-measure to determine whether the OP level selection was adequate. Again, the OP level can be changed any time without adversely affecting the drive.

The Bottom Line

SSDs targeted for client applications tend to have minimal amounts of native OP for use in background operations like garbage collection and wear-leveling. When an SSD is nearly full, this can hinder performance under some heavy workloads. Setting aside some space for OP can improve performance and reduce wear of the SSD.

Micron's Storage Executive software can be used to modify partitions to effectively supplement the native OP of Micron's client SSDs with additional space. Storage Executive software can also be used to monitor the WAF, which can be used as a guide to estimating the appropriate OP level.

Additional Resources

» Over-Provisioning the M600 SSD for Data Center Applications Technical Brief

» Calculating the Write Amplification Factor

» Storage Executive Software Download and Resources

» Storage Executive Software User Guide

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