

Intel[®] Solid-State Drive Optimizer

Getting the most out of your 34nm Intel[®] X25-M and X18-M Solid-State Drive.

White Paper

Intel[®] SSD Optimizer

Abstract

Today, when a user deletes a file from their system, the host only deletes a pointer in the OS file system. This action does not physically erase the data from the drive. While the deleted data no longer appears valid to the OS, it still appears valid to the drive firmware. Since no run time is spent by the drive to physically erase the targeted data this makes the OS operation fast. In terms of performance this method may be advantageous for traditional hard disk drives; however, it provides an unnecessary constraint for solid-state drives (SSDs) because they offer higher levels of performance when they hold less data.

To remove this unwanted constraint, Intel is introducing the Intel[®] SSD Optimizer for its 34nm series of X25-M and X18-M solid-state drives. This new feature will bring to the end user the ability to retain "out of box" performance levels over the life of the drive.

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Introduction

Unlike traditional hard disk drives, it is advantageous to tell an SSD when you delete files. At some point every 4KB page has been written to once, and you have to start overwriting old existing data. Unlike spinning media, Flash media can not simply overwrite existing data and must first perform a 512KB block erase. To overwrite existing data, an SSD requires a longer read-modify-write operation which is the basis for slowing write performance as the drive fills.

Previously, there was no ATA command that would physically erase user-deleted data from a storage device. The Intel® SSD Optimizer takes advantage of the new DATA SET MANAGEMENT command now available in the ATA8-ACS-2 specification. A feature of this new command is known as “Trim”, which allows the host to collect file system information from the OS and proactively send it to the drive. By knowing which files are no longer valid, the drive can better manage its operations. Figures 1 and 2 below illustrate how the OS file system and SSD firmware view deleted files before and after the Intel® SSD Optimizer is used.

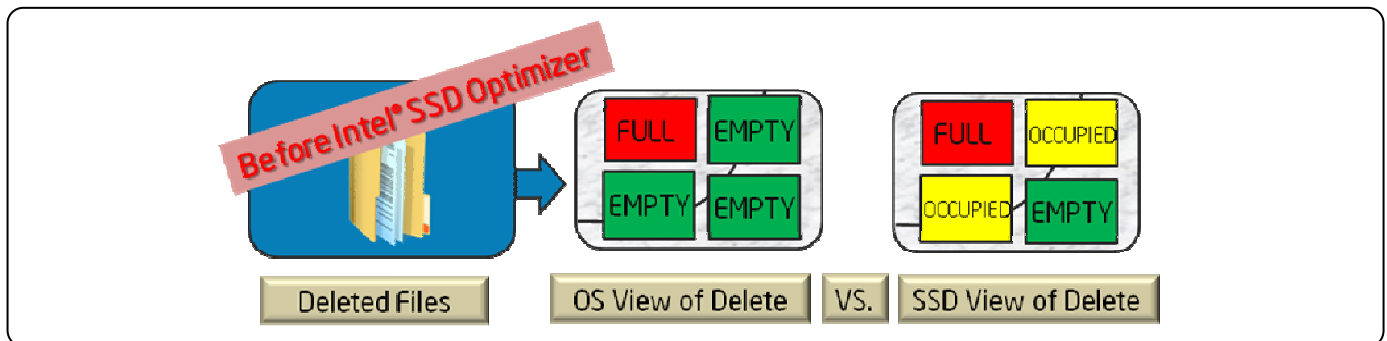


Figure 1. OS versus SSD View of Deleted Files before Intel® SSD Optimizer

In Figure 1 above, there exists a visible difference between what the OS and SSD each views as empty space. While Microsoft Windows* may accurately report a large amount of free space available on the drive, the SSD firmware is only aware of a much smaller amount of existing free space.

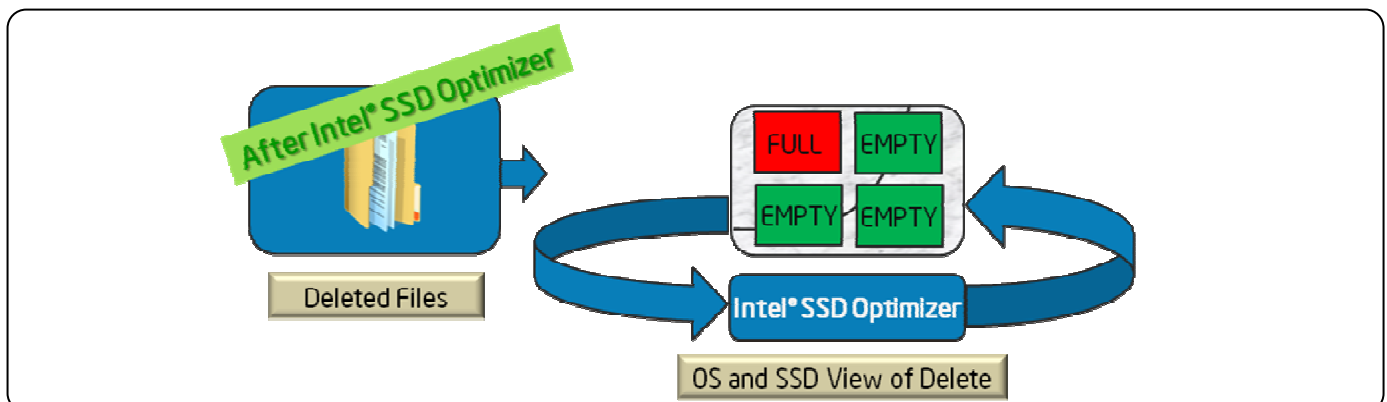


Figure 2. OS versus SSD view of deleted files after Intel® SSD Optimizer

After the Intel® SSD Optimizer has executed in Figure 2, the SSD now shares the same view of deleted files as the OS file system. The free space on the SSD is now equal to the free space the OS reports to the user.

Benefit

It is well known that SSDs perform to higher levels when they are tested in their new “out of box” state. Many technical press reviewers have gone to great lengths to test SSDs not only in their new “out of box” state, but also after the drives have been subjected to heavy usage. Often these resulting numbers can be quite different. What the Intel® SSD Optimizer brings to the end user is the ability to retain the “out of box” performance levels over the life of the drive.

The graph in Figure 3 illustrates expected performance trends of an Intel® X25-M or X18-M SSD as the drive becomes filled over time. Without the Intel® SSD Optimizer, the performance of the drive will begin to slow as it fills. As free space on the drive begins to deplete, more writes to the drive will now require longer read-modify-write operations resulting in slowing write performance over time. Since deleting files at the OS level does not result in recovered free space on the drive this represents a downward trend for performance over time. With the Intel® SSD Optimizer the drive is now capable of recovering free space when the user deletes files at the OS level. Resulting writes to free space occur much faster than longer read-modify-write operations required when overwriting existing data. The end result is a recoverable path to “out of box” performance levels over the life of the drive.

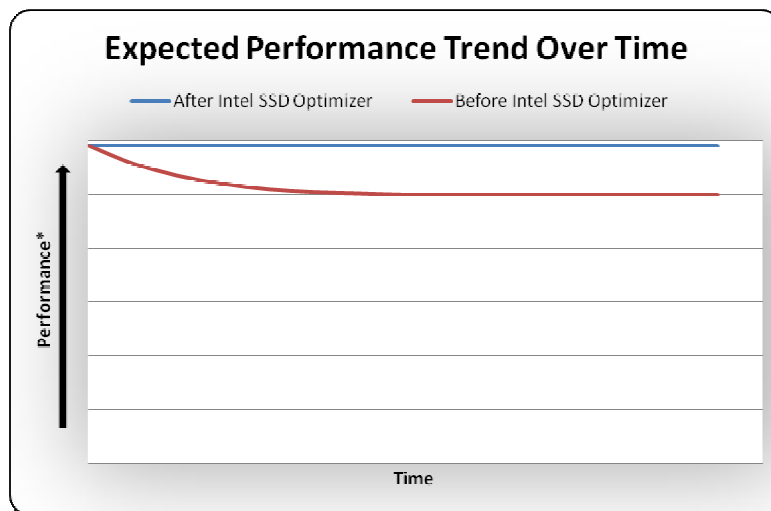


Figure 3. Performance trend of the Intel® SSD Optimizer

* Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance.

System and SSD Requirements

Any 34nm Intel® X25-M or X18-M solid-state drives running firmware version 02HA or later will contain support for the ATA DATA SET MANAGEMENT (trim) command. Current implementation does not support multiple Intel solid-state drives configured as part of an OS RAID set. When using the latest Microsoft Windows* 7 operating system with the Microsoft AHCI storage driver, the OS will contain native support to execute the ATA Data Set Management command on an Intel SSD without any user interaction required. For users of Windows 7 using Intel® Matrix Storage Manager storage driver, or other operating systems such as Microsoft Windows XP or Vista*, Intel is offering the same ability for users to execute the ATA Data Set Management command on their Intel SSD through the use of the Intel® SSD Optimizer tool. Instructions for

using the Intel® SSD Optimizer can be found in the next section as well as the user manual found within the Intel® SSD Toolbox download. Table 1 summarizes the system requirements in order to support trim on a 34nm Intel X25-M or X18-M SSD.

Operating System	Storage Driver	Execution Environment
Microsoft Windows* 7	Microsoft* AHCI	Native OS trim support enabled (Intel® SSD Optimizer not required)
Microsoft Windows 7	Intel® Matrix Storage Manager**	Intel® SSD Optimizer required
Microsoft Windows Vista* or XP	Microsoft AHCI or Intel® Matrix Storage Manager	Intel® SSD Optimizer required

Table 1. Intel® SSD Trim Requirements Matrix

* Other names and brands may be claimed as the property of others

** The Intel® Matrix Storage Manager driver currently does not support pass through of the ATA trim command required under Windows 7 OS. The Intel® SSD Optimizer must be used until support is included in a future release of the driver.

Intel® Solid-State Drive Optimizer Operation

Any user not running Microsoft Windows 7 with the Microsoft AHCI storage driver must use the Intel® SSD Optimizer tool found within the Intel® SSD Toolbox in order to trim their Intel SSD. After installing the Intel® Solid-State Drive Toolbox the user will be presented with the following home screen shown in Figure 4.

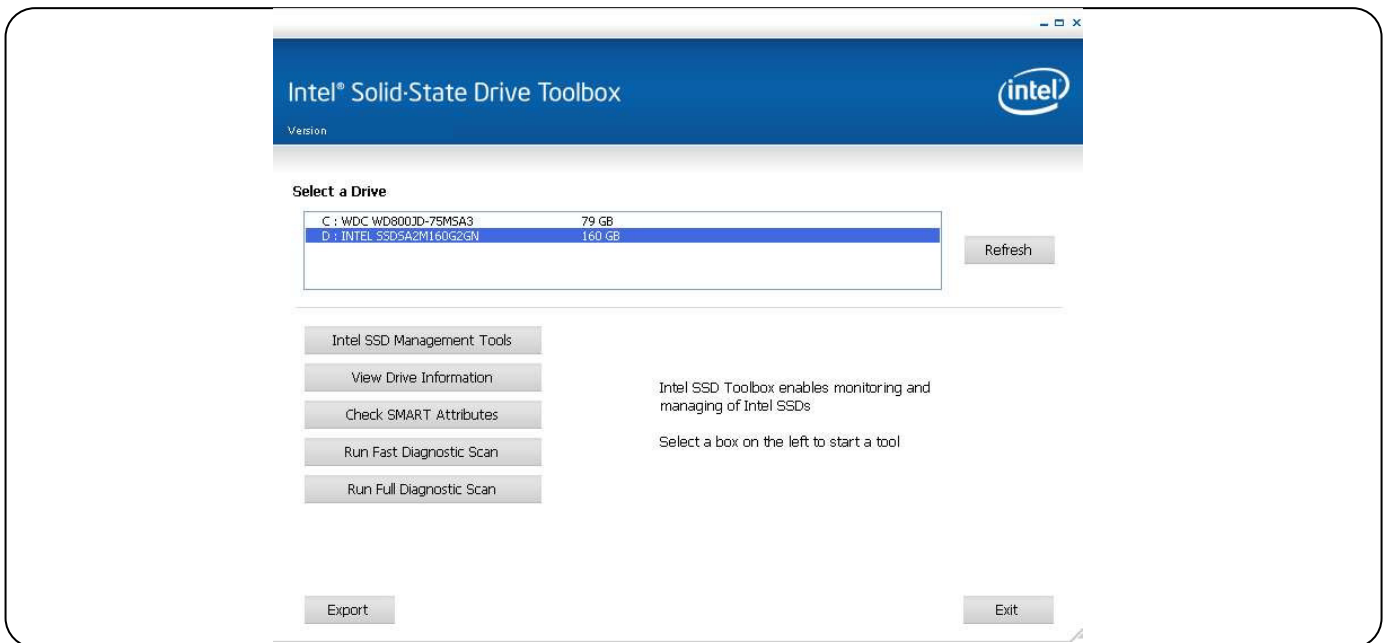


Figure 4. Intel® Solid-State Drive Toolbox home screen

If multiple drives exist in the system, select the Intel SSD. Note: The Intel® SSD Toolbox will not execute the Intel® SSD Optimizer on Intel 50nm or non-Intel SSDs. The tab titled "Intel SSD Management Tools" will

navigate the user to the following screen shown in Figure 5. From here, the user can choose to manually run the Intel® SSD Optimizer or create a schedule for it to run automatically at a desired time and interval. If choosing to manually run the tool the user will see a progress bar appear in the lower left corner indicating when the Intel® SSD Optimizer has completed running.

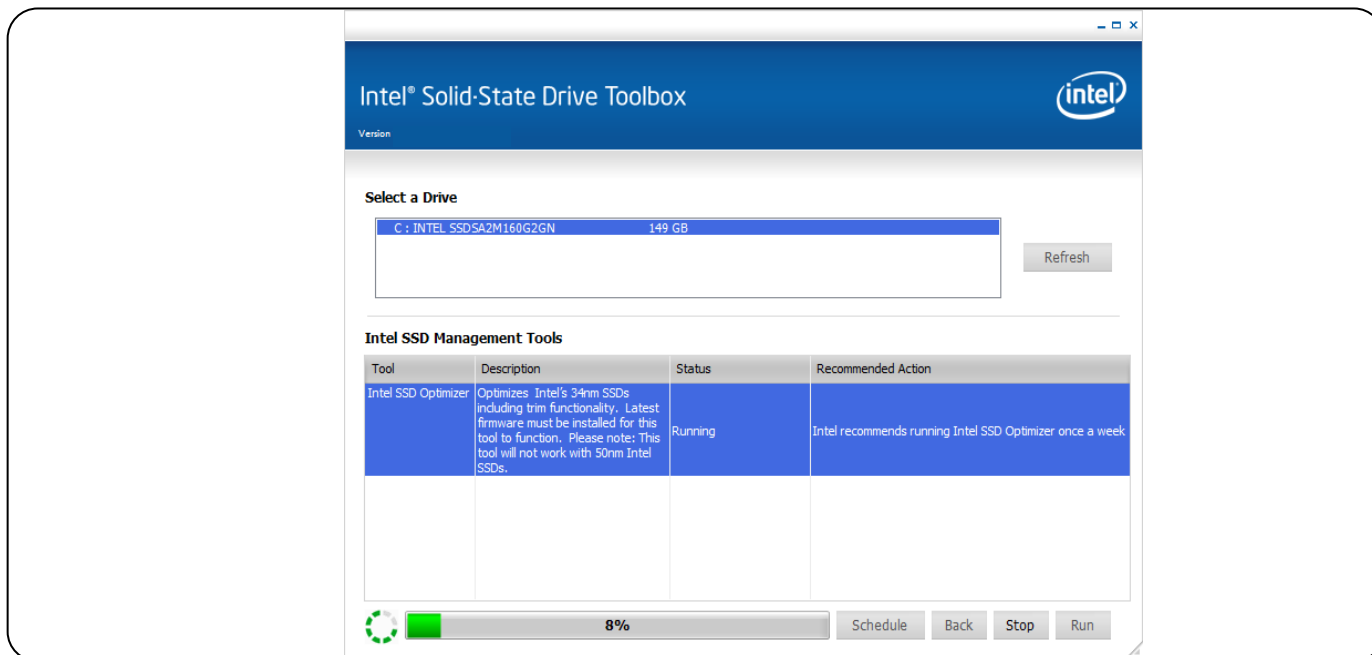


Figure 5. Example of the Intel® SSD Optimizer undergoing a manual execution

If the user chooses to create a schedule, they will be presented with the following screen shown in Figure 6.

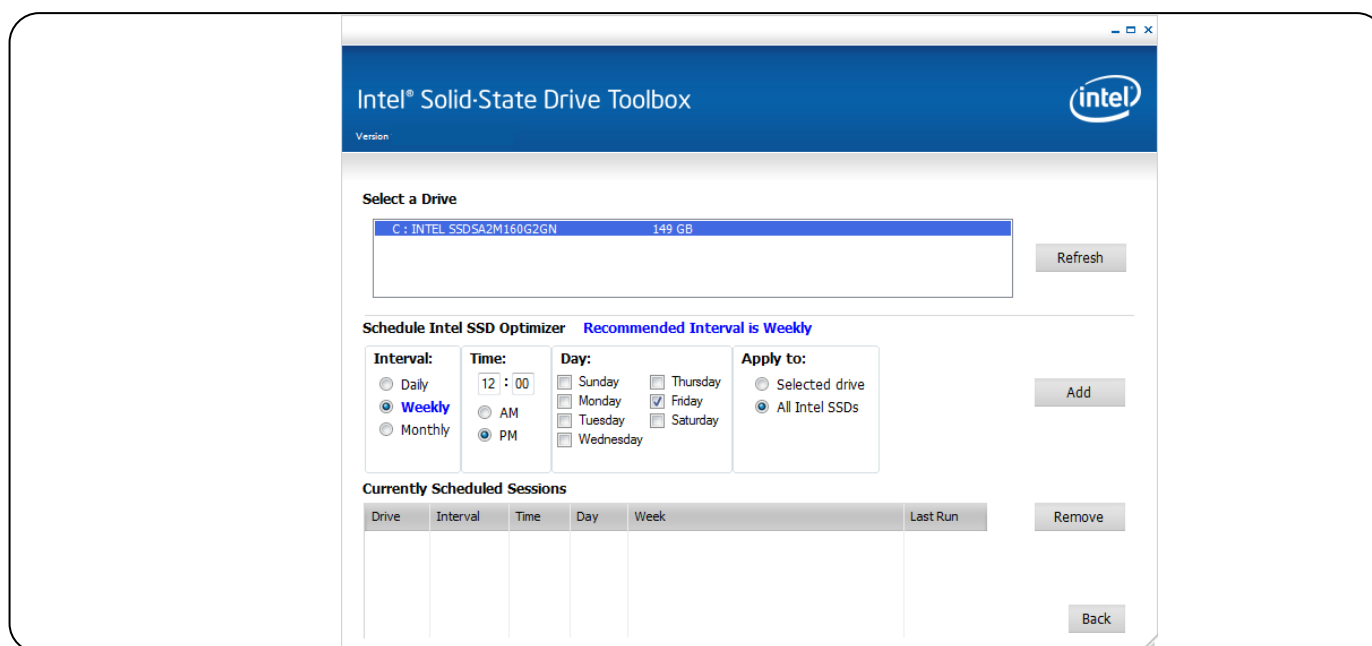


Figure 6. Intel® SSD Optimizer scheduler function

The Intel® SSD Optimizer scheduler function allows the user to select a desired interval for execution of the Intel® SSD Optimizer (daily, weekly, or monthly). Once an interval and time have been chosen, the user must add it to the list of scheduled sessions in order for it to run.

Various warning messages could appear when the user attempts to run the Intel® SSD Optimizer based on system configuration or OS background processes identified to be running. Examples of these additional warning messages can be found in the Intel® SSD Toolbox users guide contained within the toolbox download.

Summary

We have shown that the lack of a drive level delete in traditional ATA commands can place unwanted constraints on SSDs that can lead to slowing performance of the drive over time or after heavy usage. To remove these unwanted constraints Intel is introducing the Intel® SSD Optimizer for its 34nm series of X25-M and X18-M solid-state drives. This new feature will bring to the end user the ability to retain “out of box” performance levels over the life of the drive. While users of Microsoft Windows* 7 will have native support built into the OS to take advantage of this new feature, Intel is also offering support for users of other Windows operating systems through the use of the Intel® SSD Optimizer tool.

Frequently Asked Questions

- Q1 How often should I run the Intel® SSD Optimizer on my SSD? How long does it take to complete? Can overuse cause problems?**
- A1 Intel recommends scheduling the Intel® SSD Optimizer to run on a weekly basis. Total execution time under Windows XP is very fast and in most cases will complete in a number of seconds. Windows Vista and Windows 7 execution times can take much longer, anywhere from a few minutes up to 30min or even longer in extreme cases. These longer run times are based on the number of system restore points that have been saved by the OS. There is no known risk of harm to the SSD due to continuous repeated use of the tool.
- Q2 Will the Intel® SSD Optimizer work with my drive encryption software?**
- A2 Yes, the Intel® SSD Toolbox will work with encryption software. On Windows Vista* or Windows 7, a prompt will appear within the Intel® SSD Toolbox allowing the user to force the Intel® SSD Optimizer to execute if the user can verify that their Intel SSD is not part of a RAID array. Clicking “accept” will optimize the drive successfully. On Microsoft Windows* XP, it will work with no additional user input required.
- Q3 Can I use the Intel® SSD Optimizer if I have multiple Intel SSDs configured as part of a RAID set?**
- A3 Current implementation of the Intel® SSD Toolbox will not support SSDs configured as part of an OS RAID set. Intel is looking at including support in future versions of the tool.
- Q4 Does the Intel® SSD Optimizer delete OS level files?**
- A4 No, the Intel® SSD Optimizer interprets files that have been deleted from the file system, but whose physical location on the SSD has yet to be cleared. It then actively passes that information to the SSD where the data is physically erased at the drive level.

Q5 Will the Intel® SSD Optimizer delete files that reside in my recycle bin?

A5 No, files that reside in Windows recycle bin have not yet been marked for deletion by the OS file system and as a result will not be deleted by the Intel® SSD Optimizer. When the recycle bin has been emptied by the user, those files will now physically be deleted from the drive by the next Intel® SSD Optimizer run. Additionally, the “un-delete” applications function will not be able to recover any data after an Intel® SSD Optimizer execution has taken place.

Q6 Will my 34nm Intel SSD see a performance increase immediately after running the Intel® SSD Optimizer?

A6 Generally yes, however it will heavily depend on the prior state of the drive. If the drive is encountering slowing performance due to heavy usage, performance should quickly return to “out of box” levels after running the Intel® SSD Optimizer. However, if the drive has seen little usage prior to running the Intel® SSD Optimizer, the user may not notice a substantial performance increase since the drive is already operating at or near optimal performance levels. Frequent use of the Intel® SSD Optimizer will ensure optimal performance levels are maintained over the life of the drive.

Q7 If I never delete files from my system will I see a benefit from the Intel® SSD Optimizer?

A7 While there should still be some benefit related to OS level cleanup of temp files, temp directories, and installers, the Intel® SSD Optimizer will result in higher levels of performance if unwanted files are deleted by the user. In order to see the most benefit it is recommended that users actively delete any unwanted files from their system in addition to frequently running disk cleanup utilities.

Q8 Is the Intel® SSD Optimizer supported under Linux?

A8 Not at this time, however Intel is actively working with the Linux community to enable support for the Intel® SSD Optimizer in the Linux storage drivers. We expect support to be available soon; thus, we have no plans to create a version of the Intel® SSD Toolbox for Linux.

Related Documents

Document	Location
ATA8-ACS-2 Specification	d2015r1a-ATAATAPI_Command_Set_-_2_ACS-2.pdf
Intel® SSD Toolbox Users Guide	Included in Intel® SSD Toolbox download

For more information about Intel® High Performance SATA Solid-State Drives, visit www.intel.com/go/ssd

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