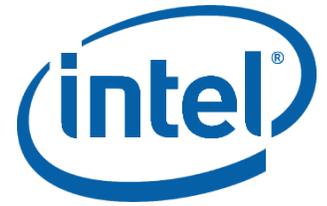


Intel[®] High Performance SATA Solid-State Drive

Over-provisioning an Intel[®] SSD



Contents

Introduction	3
Spare Area Allocation.....	3
Steps to Increase Spare Area.....	3
Conclusion.....	3

INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

A "Mission Critical Application" is any application in which failure of the Intel Product could result, directly or indirectly, in personal injury or death. SHOULD YOU PURCHASE OR USE INTEL'S PRODUCTS FOR ANY SUCH MISSION CRITICAL APPLICATION, YOU SHALL INDEMNIFY AND HOLD INTEL AND ITS SUBSIDIARIES, SUBCONTRACTORS AND AFFILIATES, AND THE DIRECTORS, OFFICERS, AND EMPLOYEES OF EACH, HARMLESS AGAINST ALL CLAIMS COSTS, DAMAGES, AND EXPENSES AND REASONABLE ATTORNEYS' FEES ARISING OUT OF, DIRECTLY OR INDIRECTLY, ANY CLAIM OF PRODUCT LIABILITY, PERSONAL INJURY, OR DEATH ARISING IN ANY WAY OUT OF SUCH MISSION CRITICAL APPLICATION, WHETHER OR NOT INTEL OR ITS SUBCONTRACTOR WAS NEGLIGENT IN THE DESIGN, MANUFACTURE, OR WARNING OF THE INTEL PRODUCT OR ANY OF ITS PARTS.

Intel may make changes to specifications and product descriptions at any time, without notice. Designers must not rely on the absence or characteristics of any features or instructions marked "reserved" or "undefined". Intel reserves these for future definition and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to them. The information here is subject to change without notice. Do not finalize a design with this information.

The products described in this document may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.

Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.

Copies of documents which have an order number and are referenced in this document, or other Intel literature, may be obtained by calling 1-800-548-4725, or go to: <http://www.intel.com/design/literature.htm>

Performance results are based on certain tests measured on specific computer systems. Any difference in system hardware, software or configuration will affect actual performance. Measurements made using desktop system with Intel® Core™2 Duo CPU E4500 @ 2.20GHz and 1GB PC2-5300 Memory running Microsoft Windows® XP SP3 O/S and Intel® Matrix Storage Manager. Performance measurements are made using specific computer systems and/or components and reflect the approximate performance of the technology as measured by those tests. Any difference in system hardware or software design or configuration may affect actual results. For more information go to: <http://www.intel.com/performance>.

Intel and the Intel logo are trademarks of Intel Corporation in the U.S. and other countries.

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

Copyright © 2012 Intel Corporation. All rights reserved.

324441-002

Introduction

Over-provisioning is a term used to describe the process of increasing the spare area on a solid-state drive (SSD). Much like “short stroking” a hard disk drive (HDD), over-provisioning an SSD increases the performance and endurance of an SSD.

This document provides details on the items that can be modified to over-provision an Intel SSD.

Spare Area Allocation

Increasing the spare area allocation of an SSD will result in random write performance improvement as well as endurance gains. Increasing this area, also known as “over-provisioning”, is similar to the concept HDD users term “short stroking” the drive. Enlarging the spare area increases the available “ready to be written” resource pool which decreases write amplification. Since there is less background data movement required, performance and endurance increases.

Figure 1 shows Intel® 320 series with 20% and 40% over-provisioning compared to no over-provisioning on 160GB, 300GB, and 600GB user capacity skews. Your results may vary depending on the usage model.

Steps to Increase Spare Area

The spare area of an SSD can be modified by a user. It must be performed on an SSD that is in a completely clean state. This can be an SSD that is fresh out of the box that has never been used or by secure erasing the SSD.

To secure erase an Intel SSD, download Intel® Solid-State Drive Toolbox 3.0.2 from [Intel SSD Toolbox](#) and follow the steps for performing a secure erase on the SSD. (Industry tools are also available to secure erase an SSD using ATA commands.)

Once the SSD is in a clean state, reduce the usable capacity (which increases the spare area) using one of two methods:

- Issue the SET MAX ADDRESS command (part of the ATA specification) to set the maximum address the operating system (OS) can see. HDPARM* and HDAT2* are third-party industry tools that can be used to issue this command.
- Define a partition that is less than the maximum available capacity of the SSD. This option can be found in the OS drive configuration tools.

Both SET MAX ADDRESS and partitioning will reduce the user addressable space and allow the SSD to use the remaining space as part of the “ready to be written” resource pool.

Note:

- Spare Capacity = Raw NAND Capacity – User Capacity
- Over-provisioning means increasing spare capacity by decreasing user capacity
- Larger spare capacity reduces defrag overhead
- Larger spare capacity improves performance and endurance with random write workloads

HDAT2* usage:

- Install HDAT2* to a DOS bootable USB Drive
- BIOS needs to be changed from AHCI TO IDE (Native)
- During the boot don't hook up the drive - Bios puts a freeze on the drive through SATA. Always hot plug-in once it reaches the C:> prompt.
- Run C:\HDAT2* from the Command line
- Select the Intel SSD, hit return
- Select "SET MAX (HPA) Menu
- Select "Set Max Address"
- For example: Intel 320 series 300GB shows total 586072368 LBAs. So LBAs Per 1GB = 586072368/300 which is equal to 1953574 LBAs. Total 20% over-provisioning means reducing the user capacity by 60GB. Hence 60GBx195357 LBAs = 117214440 total LBAs.
- Hit the "Insert" key to enable entering a value in the *New hidden*. Enter in 117214440, hit return
- Now, note that the user area is showing 240GB
- Hidden Area is showing 60GB
- Hit "S" to set this amount then hit "Y"
- The bottom of the screen will show that the command to the drive was set correctly.
- The new HPA is now set. It will stay intact for power cycles.

HDPARM* usage:

- Use HDPARM* (-Np command) under Linux or DOS
 - Example setting 128GiB visible capacity (capacity provided in 512B sectors -1):
`hdparm -Np268435455 --yes-i-know-what-i-am-doing /dev/sdX`
 - Power-cycle the drive after setting Max LBA
- Once written, data occupies space on the drives until Security Erase done
- Deleting files, formatting, deleting partitions, deleting RAID logical drives is NOT enough - SSD does not know about you doing this
- Security Erase resets SSDs to their cleanest state

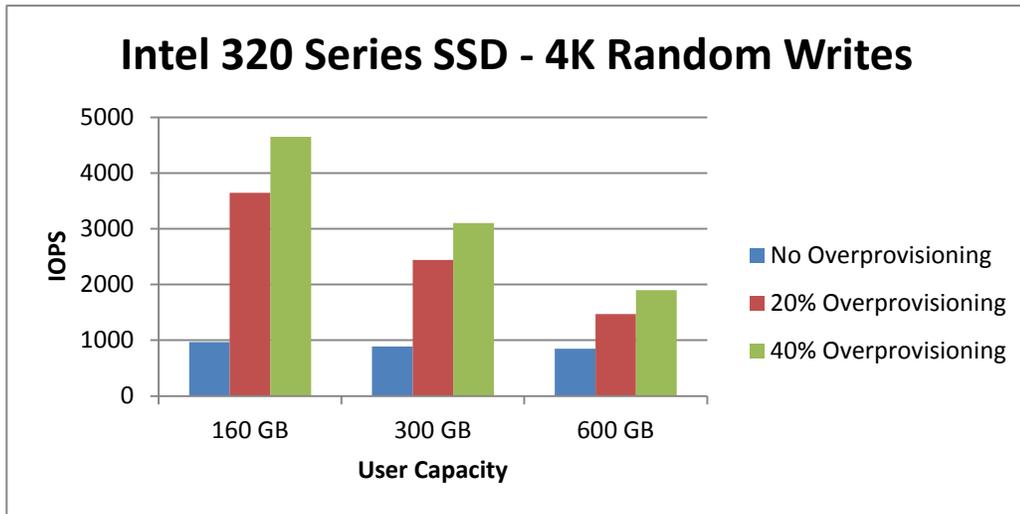


Figure 1.

Conclusion

Users can increase the performance of a solid-state drive by over-provisioning the SSD. Users must ensure a “clean” SSD before setting the maximum address or partitioning the SSD.

For more information about Intel SATA Solid State Drives, visit [Intel SSD](#).

¹ Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Firmware 3.02 measured with 4KB transfer size 100% Random Writes.

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

Third-party tools require a separate non-Intel license agreement and are not supported by Intel.

Reference Document: SATA Rev 2.6 Specification, February 2007, <http://www.sata-io.org>