

ATA Trim/Delete Notification Support in Windows 7

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What we'll cover

- ❑ Improve Windows performance on SSD (Solid State Devices) by increasing wear level effectiveness
 - ❑ Communicate deleted block information from the file system
 - ❑ Disable scheduled defrag operation

The ATA Command Set

ATA-7 Hard Drive Commands			
Read Commands	Write Commands	Power Management	Other
		CHECK POWER MODE	CONFIGURE STREAM
READ DMA	WRITE DMA	IDLE	DEVICE CONFIGURATION
READ DMA EXT	WRITE DMA EXT	IDLE IMMEDIATE	DOWNLOAD MICROCODE
	WRITE DMA FUA EXT	SLEEP	EXECUTE DEVICE DIAGNOSTIC
READ DMA QUEUED	WRITE DMA QUEUED	STANDBY	FLUSH CACHE
READ DMA QUEUED EXT	WRITE DMA QUEUED EXT	STANDBY IMMEDIATE	FLUSH CACHE EXT
	WRITE DMA QUEUED FUA EXT		IDENTIFY DEVICE
READ FPDMA QUEUED	WRITE FPDMA QUEUED		NOP
READ MULTIPLE	WRITE MULTIPLE		READ LOG EXT
READ MULTIPLE EXT	WRITE MULTIPLE EXT		READ NATIVE MAX ADDRESS
	WRITE MULTIPLE FUA EXT		READ NATIVE MAX ADDRESS EXT
READ SECTOR(S)	WRITE SECTOR(S)		SERVICE
READ SECTOR(S) EXT	WRITE SECTOR(S) EXT		SET FEATURES
READ STREAM DMA EXT	WRITE STREAM DMA EXT		SET MAX ADDRESS
READ STREAM EXT	WRITE STREAM EXT		SET MAX ADDRESS EXT
READ VERIFY SECTOR(S)			SET MULTIPLE MODE
READ VERIFY SECTOR(S) EXT			SMART
			WRITE LOG EXT

Most of the IO traffic from Windows : Queued IO and durability control

- Notice there are lots of flavors of Read and Write
- What was missing :

“I no longer need the data in this sector now”

- “Trim” addresses this

Why Trim is Important?

- ❑ Trim is important to SSDs because:
 - ❑ They spend a lot of resources (processor time and internal storage) wear-leveling
 - ❑ Free blocks are used to make wear-leveling algorithms more effective
 - ❑ The more free blocks, the easier it is to wear level

Why Trim is Important? (cont'd)

- ❑ Some SSDs have tried to work around lack of Trim by trying to interpret and understand the file system format such that they can free blocks when a file is marked deleted.
 - ❑ Works for FAT since it's a published spec
 - ❑ Does not work well for NTFS
 - ❑ NTFS structures are much more complex than FAT
 - ❑ NTFS structures are not published and will change in the future

- Trim is only implemented by the NTFS File System
- How Trim is Implemented:
 - Application calls DeleteFile
 - File system metadata is updated and written to device
 - Metadata is flushed and checkpoint record written to log
 - **Device is notified that blocks are no longer in use**
 - Blocks are made marked as free in volume bitmap

- ❑ “A write will be issued before another read is issued for this range”... If a read comes down before the first write after a Trim, the data returned can be :
 - ❑ The last data written to the range
 - ❑ A fixed pattern (zeros or ones)
 - ❑ **Can not be other data pages on the device**
 - ❑ Trim should not expose security hole

Trim Semantics (cont'd)

- Trim differs from “Secure Delete” command
 - Secure Delete means it must be done
 - Trim is just an advisory... don't take the perf hit of flushing zeroes out

- ❑ “DRAT” is Deterministic Read After Trim
 - ❑ Trim command can be done synchronously or in background
 - ❑ If DRAT is set, then results for read of trimmed area must not change after the first read after Trim.
 - ❑ If DRAT is not set, then results for read of trimmed area are non deterministic
 - ❑ Could be old data or all zeros or all ones

- ❑ DRAT is currently unused by Windows 7 because NTFS never lets applications read the trimmed data

- ❑ Two ATA methods to send down a Trim
 - ❑ Both use Data Set Management (DSM) to set attributes
 - ❑ Trim in this case is the attribute that is set on the data

- ❑ ATA DSM Command with Trim

- ❑ FPDMA Send with DSM Trim

- ❑ Method #1 : ATA DSM Trim
 - ❑ One TRIM command potentially has multiple ranges to be trimmed
 - ❑ The list of ranges is sent in the data transfer phase of the request
 - ❑ Disrupts NCQ queuing

Identify for ATA DSM with Trim

State Listing

Store #	Timestamp	L1 I->T Data	L1 I->T Count	L1 I->T Description
124,387	16 ns	2780EC00	0	FIS 27 - Reg Host->Device Features = 0x00=Reserved Command = 0xEC=IDENTIFY DRIVE C = 1 - Command Register Updated PM Port = 0x0 - Default Port
124,388	12 ns	00000040	1	Dev/Head = 0xA0 Cyl High = 0x00 Cyl Low = 0x00 Sec Num = 0x00
124,389	12 ns	00000000	2	Features(exp) = 0x00 Cyl High(exp) = 0x00 Cyl Low(exp) = 0x00 Sec Num(exp) = 0x00
124,390	16 ns	01000000	3	Control = 0x00 Sec Cnt(exp) = 0x00 Sec Cnt = 0x01
124,391	12 ns	00000000	4	Reserved
124,392	12 ns	2FC1492A	5	
124,393	16 ns	7CB5D5D5		CRC - Good SATA EOF

L1 I->T L2 I->T L3 I->T L4 I->T
 L1 T->I L2 T->I L3 T->I L4 T->I

Reverse Byte Order

Store #	Hex	ASCII
124423	46000000 4000FF3F 37C81000 00000000	F...0...?7.....
124427	3F000000 00000000 56434D45 33383132	?.....VCH83812
124431	30303147 38304430 4E472020 00000000	...01G80DONG
124436	00003430 43353638 42344E49 4554204C	...40C568B4NIET L
124441	53535344 3241484D 38304730 4731204E	SSSD2AHM80G0G1 N
124445	20202020 20202020 20202020 20202020	...../..0.....
124449	20201080 0000002F 00400000 00000700	.....?..?.....P
124453	FF3F1000 3F0010FC FB000101 B0F85009	.....x..x..x..x
124457	00000700 03007800 78007800 78000000	.....P..
124461	00000000 00000000 00001E00 06010000	.....#a.....
124465	48004000 FC001A00 6B74017C 23616974	.....kt..!#ait
124469	01BC2361 7F000100 01000000 FEF00000	.....#a.....
124473	00000000 00000000 00000000 B0F85009	.....P..
124477	00000000 00000000 00000000 01507051	.....Pp0
124481	62ED392E 00000000 00000000 00000000	b..9+.....
124485	00001C40 1C400000 00000000 00000000	...0..0.....
124489	00000000 21000000 00000000 00000000!
124493	00000000 00000000 00000000 00000000	.....
124497	00000000 00000000 00000000 00000000	.....
124501	00000000 00000000 00000000 00000000	.....
124505	00000000 00000000 00000000 00000000	.....
124509	00000000 00000100 00000000 00000000	.....
124513	00000000 00000000 00000000 00000000	.....
124517	00000000 00000000 00000000 00000000	.....
124521	00000000 00000000 00000000 00000000	.....
124524	00000000 00000000 00000000 00000000	.....
124528	00000000 00000000 00000000 00000000	.....
124532	00000000 00000000 00000000 00000000	.....
124536	00000000 00000100 00000000 00000000	.....
124540	1F100000 00000000 00000000 00000000	.....
124544	00000000 00000000 0100A002 00000000	.....
124548	00000000 00000000 00000000 00000000	.....
124552	00000000 00000000 00000000 00000000	.....
124556	00000000 00000000 00000000 00000000	.....
124560	0000A52E E931B1FB	.....1..

Command Listing

Store #	Timestamp	Dir	L1-L4 Type
124,245	1.151179046 min	INIT	COMWAKE DOB
124,306	1.151179072 min	TRGT	COMWAKE DOB
124,346	1.151181072 min	TRGT	FIS 34 - Status: 0x50 - DRDY
124,386	1.151326152 min	INIT	FIS 27 - Cmd: 0xEC=IDENTIFY DRIVE
124,404	1.151328320 min	TRGT	FIS 5F - PIO Setup - Status: 0x58 - DRD
124,422	1.151328334 min	TRGT	FIS 46 - Payload Data
124,578	1.151337326 min	INIT	FIS 27 - Cmd: 0x25=READ DMA EXT
124,596	1.151338564 min	TRGT	FIS 46 - Payload Data
124,747	1.151338609 min	TRGT	FIS 34 - Status: 0x50 - DRDY
124,765	1.151347777 min	INIT	FIS 27 - Device Control Registers Update
124,783	1.151347805 min	INIT	FIS 27 - Device Control Registers Update
124,803	1.151348277 min	TRGT	FIS 34 - Status: 0x50 - DRDY

0x0001 shows that Trim support is present

DSM Command with Trim

State Listing Apply Filter Filtering... Columns...

Store #	Timestamp	L1 I->T Description
170,524	16 ns	FIS 27 - Reg Host->Device Features = 0x01=Enable 8-bit PIO Transfer Mod Command = 0x06=Reserved C = 1 - Command Register Updated PM Port = 0x0 - Default Port
170,525	8 ns	Dev/Head = 0x40 Cyl High = 0x00 Cyl Low = 0x00 Sec Num = 0x00
170,526	16 ns	Features(exp) = 0x00 Cyl High(exp) = 0x00 Cyl Low(exp) = 0x00 Sec Num(exp) = 0x00
170,527	16 ns	Control = 0x00 Sec Cnt(exp) = 0x00 Sec Cnt = 0x01 Reserved
170,528	8 ns	
170,529	16 ns	
170,530	16 ns	CRC - Good

Command Listing Apply Filter Filtering... Columns...

Store #	Timestamp	Dir	L1-L4 Type
168,040	2.038560899 min	TRGT	FIS 39 - DMA Activate
168,054	2.038560915 min	INIT	FIS 46 - Payload Data
168,196	2.038560959 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
168,211	2.038561035 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
168,233	2.038561050 min	TRGT	FIS 39 - DMA Activate
168,247	2.038561066 min	INIT	FIS 46 - Payload Data
168,391	2.038561109 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
168,406	2.038561185 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
168,426	2.038561200 min	TRGT	FIS 39 - DMA Activate
168,441	2.038561216 min	INIT	FIS 46 - Payload Data
168,583	2.038561260 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
168,600	2.038561336 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
168,620	2.038561351 min	TRGT	FIS 39 - DMA Activate
168,634	2.038561366 min	INIT	FIS 46 - Payload Data
168,776	2.038561411 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
168,791	2.038561487 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
168,813	2.038561502 min	TRGT	FIS 39 - DMA Activate
168,827	2.038561517 min	INIT	FIS 46 - Payload Data
168,970	2.038561562 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
168,985	2.038561637 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
169,005	2.038561652 min	TRGT	FIS 39 - DMA Activate
169,021	2.038561667 min	INIT	FIS 46 - Payload Data
169,163	2.038561711 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
169,178	2.038561788 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
169,198	2.038561802 min	TRGT	FIS 39 - DMA Activate
169,212	2.038561818 min	INIT	FIS 46 - Payload Data
169,354	2.038561862 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
169,369	2.038561938 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
169,391	2.038561954 min	TRGT	FIS 39 - DMA Activate
169,405	2.038561970 min	INIT	FIS 46 - Payload Data
169,547	2.038562014 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
169,562	2.038562089 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
169,582	2.038562104 min	TRGT	FIS 39 - DMA Activate
169,596	2.038562120 min	INIT	FIS 46 - Payload Data
169,738	2.038562163 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
169,753	2.038562240 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
169,773	2.038562254 min	TRGT	FIS 39 - DMA Activate
169,787	2.038562270 min	INIT	FIS 46 - Payload Data
169,929	2.038562314 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
169,944	2.038562390 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
169,964	2.038562405 min	TRGT	FIS 39 - DMA Activate
169,980	2.038562421 min	INIT	FIS 46 - Payload Data
170,124	2.038562465 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
170,139	2.038562541 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
170,159	2.038562556 min	TRGT	FIS 39 - DMA Activate
170,173	2.038562572 min	INIT	FIS 46 - Payload Data
170,315	2.038562616 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
170,330	2.038562691 min	TRGT	FIS 41 - DMA Setup - A: 0 I: 0 D: 0
170,352	2.038562706 min	TRGT	FIS 39 - DMA Activate
170,366	2.038562722 min	INIT	FIS 46 - Payload Data
170,508	2.038562766 min	TRGT	FIS A1 - Set Device Bit - I: 1 Err: 0x00
170,523	2.038562959 min	INIT	FIS 27 - Cmd: 0x06=Reserved
170,541	2.038566931 min	TRGT	FIS 39 - DMA Activate
170,555	2.038566946 min	INIT	FIS 46 - Payload Data

L1 I->T L2 I->T L3 I->T L4 I->T
 L1 T->I L2 T->I L3 T->I L4 T->I

ASCII

Store #	Hex	ASCII
170556	46000000 48B05E00 00001802 00000000	F...H...
170566	00000000 00000000 00000000 00000000	.....
170570	00000000 00000000 00000000 00000000	.....
170574	00000000 00000000 00000000 00000000	.....
170580	00000000 00000000 00000000 00000000	.....
170584	00000000 00000000 00000000 00000000	.....
170588	00000000 00000000 00000000 00000000	.....
170592	00000000 00000000 00000000 00000000	.....
170596	00000000 00000000 00000000 00000000	.....
170600	00000000 00000000 00000000 00000000	.....
170604	00000000 00000000 00000000 00000000	.....
170608	00000000 00000000 00000000 00000000	.....
170612	00000000 00000000 00000000 00000000	.....
170616	00000000 00000000 00000000 00000000	.....
170620	00000000 00000000 00000000 00000000	.....
170624	00000000 00000000 00000000 00000000	.....
170628	00000000 00000000 00000000 00000000	.....
170632	00000000 00000000 00000000 00000000	.....
170636	00000000 00000000 00000000 00000000	.....
170640	00000000 00000000 00000000 00000000	.....
170644	00000000 00000000 00000000 00000000	.....
170648	00000000 00000000 00000000 00000000	.....
170652	00000000 00000000 00000000 00000000	.....
170656	00000000 00000000 00000000 00000000	.....
170660	00000000 00000000 00000000 00000000	.....
170664	00000000 00000000 00000000 00000000	.....
170668	00000000 00000000 00000000 00000000	.....
170674	00000000 00000000 00000000 00000000	.....
170678	00000000 00000000 00000000 00000000	.....
170682	00000000 00000000 00000000 00000000	.....
170691	00000000 00000000 00000000 00000000	.....
170695	00000000 00000000 00000000 00000000	.....

LBA and length to be trimmed. Could be up to 64 ranges present per block. Up to 16K blocks per request.

FPDMA Send with DSM Trim

- Method #2 : FPDMA Send with DSM Trim
 - Does not disrupt NCQ queuing
 - Not currently used by Windows 7 inbox ATA driver
 - May be supported in future version of Windows inbox ATA driver

IDENTIFY

The screenshot displays three main windows from a storage analysis tool:

- State Listing:** Shows a table of states for Store # 633 through 638. The 'Description' column for Store # 633 is highlighted in red and contains:
 - FIS 27 - Reg Host->Device
 - Features = 0x00=Reserved
 - Command = 0xEC=IDENTIFY DRIVE
 - C = 1 - Command Register Updated
 - PM Port = 0x0 - Default Port
 A callout box points to this section with the text: "Check if general purpose logging is supported and enabled".
- Command Listing:** Shows a table of commands. The entry for Store # 632 is highlighted in red and contains:
 - Link: 1
 - Speed: 3 Gbps
 - Dir: INIT
 - L1-L4 Type: FIS 27 - Cmd: 0xEC=IDENTIFY DRIVE
 A callout box points to this entry with the text: "Send FPDMA is supported".
- Hex View:** Shows a hex dump of data. The value 0x2361 is highlighted in red in the hex column. A callout box points to this value with the text: "Send FPDMA is supported".

At the bottom of the tool, there is a histogram and a waveform display.

Read Log Pages Supported

The screenshot displays three main windows from a SATA diagnostic tool:

- State Listing:** Shows a table of SATA states. The entry for Store # 827 is highlighted with a red circle. The description for this state includes:
 - FIS 27 - Reg Host->Device
 - Features = 0x00=Reserved
 - Command = 0x2F=READ LOG EXT
 - C = 1 - Command Register Updated
 - PM Port = 0x0 - Default Port
 - Dev/Head = 0xA0
 - Cyl High = 0x00
 - Cyl Low = 0x00
 - Sec Num = 0x00
- Command Listing:** Shows a table of commands. The entry for Store # 825 is highlighted with a red circle. The description for this command includes:
 - FIS 27 - Cmd: 0x2F=READ LOG EXT
 - FIS 27 - Cmd: 0x2F=RE
- Hex Data:** Shows a hex dump of data. A yellow callout box points to the data at Store # 904, which contains the value 00010000. The callout text reads: "Log Page 0x13 (FPDMA Send) Supported?".

At the bottom of the interface, there is a histogram and a status bar showing "Pured SAS AF1" and a magnification of "1x".

Read Log Page DSM

The screenshot displays a storage analysis tool interface with three main panels:

- State Listing:** Shows a table of states with columns for Store #, Timestamp, L1 I->T Count, L1 I->T Description, and L1 T->T Date. A red circle highlights the description for Store # 412: "FIS 27 - Reg Host->Device", "Features = 0x00=Reserved", "Command = 0x2F=READ LOG EXT", and "C = 1 - Command Register Updated".
- Command Listing:** Shows a table of commands with columns for Store #, Timestamp, Link, Speed, Dir, and L1-L4 Type. A red circle highlights the command for Store # 412: "FIS 27 - Cmd: 0x2F=READ LOG EXT".
- Hex Data:** Shows a table of hex data with columns for Store #, Hex, and ASCII. Two yellow callout boxes point to the hex values "01000000" at Store # 448 and "01000000" at Store # 470, with the text "Is DSM Supported?" and "Is Trim Supported?" respectively.

At the bottom of the interface, there is a histogram showing a signal waveform and a status bar with "Ored SAS AF1" and "1x" indicators.

FPDMA Send with DSM Trim

The screenshot displays three main windows from a storage analysis tool:

- State Listing:** Shows a table of states with columns for Store #, Timestamp, L1 I->T Data, L1 I->T Count, and L1 I->T Description. A red circle highlights the entry for Store # 18, which is a FIS 27 - Reg Host->Device. The description includes details like Features = 0x01, Command = 0x64, and CRC - Good.
- Command Listing:** Shows a table of commands with columns for Store #, Timestamp, Link, Speed, Dir, and L1-L4 Type. A red circle highlights the entry for Store # 17, which is a FIS 27 - Cmd: 0x64=Reserve.
- Hex View:** Shows a table of hex data with columns for Store #, Hex, and ASCII. A yellow callout box points to the hex value 48B05E00, stating: "LBA and length to be trimmed. Could be up to 64 ranges present per block. Up to 16K blocks per request."

At the bottom, there is a histogram showing the distribution of commands, errors, and data, with a filter set to "Ored SAS AF1".

- ❑ Trim is always sent by NTFS
 - ❑ Registry key exists to disable NTFS from sending Trims:
 - ❑ \HKLM\System\CurrentControlSet\Control\FileSystem\DisableDeleteNotification set to 1
 - ❑ Useful in situations where data recovery is more important than wear leveling:
 - ❑ Undelete that do not use a filter architecture
 - ❑ Unformat tools

Future Work in Trim

- Trim is ATA version coming out of T13 committee
 - ACS-2 (document ID d2015r1a)
 - FPDMA Send with DSM Trim may be supported

- Unmap is SCSI version coming out of T10 committee
 - Proposal still being negotiated

- ❑ Difference in semantics between Unmap & Trim
 - ❑ Unmap: Underlying storage may be repurposed
 - ❑ Trim: Underlying storage is still present after trim.
Future write won't fail due to space allocation
- ❑ Windows inbox storage drivers may support Unmap in future versions
- ❑ Other file systems such as FAT32 and ExFAT may support Trim in future versions of Windows

- ❑ Flash devices have limited number of erase cycles
- ❑ Rewriting blocks to get them into adjacent LBA ranges can lead to greater FLASH burnout rate
- ❑ Two things required:
 - ❑ Detect underlying storage is FLASH device
 - ❑ Disable defrag program from “optimizing” the device

- ❑ Storage device is not scheduled for defrag by default under the following circumstances:
 - ❑ SSD reports rotation speed of 1 or
 - ❑ The WinSat performance shows that the device performs over 8 MB / sec in the random read disk test
- ❑ User can still manually configure defrag for device

Identify for No Spindle Speed

State Listing

Store #	Timestamp	L1 I->T Data	L1 I->T Count	L1 I->T Description
124,387	16 ns	2780EC00	0	FIS 27 - Reg Host->Device Features = 0x00=Reserved Command = 0xEC=IDENTIFY DRIVE C = 1 - Command Register Updated PM Port = 0x0 - Default Port
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124,389	12 ns	00000000	2	Features(exp) = 0x00 Cyl High(exp) = 0x00 Cyl Low(exp) = 0x00 Sec Num(exp) = 0x00
124,390	16 ns	01000000	3	Control = 0x00 Sec Cnt(exp) = 0x00 Sec Cnt = 0x01
124,391	12 ns	00000000	4	Reserved
124,392	12 ns	2FC1492A	5	
124,393	16 ns	7CB5D5D5		CRC - Good SATA EOF

L1 I->T L2 I->T L3 I->T L4 I->T
 L1 T->I L2 T->I L3 T->I L4 T->I

Reverse Byte Order

Store #	Hex	ASCII
124423	46000000 4000FF3F 37C81000 00000000	F...@...?7.....
124427	3F000000 00000000 56434D45 33383132	?.....VCH83812
124431	30303147 38304430 4E472020 00000000	001G80DONG
124436	00003430 43353638 42344E49 4554204C	...40C568B4NIET L
124441	53535344 3241484D 38304730 4731204E	SSSD2AHM80G0G1 N
124445	20202020 20202020 20202020 20202020/..@.....
124449	20201080 0000002F 00400000 00000700	.....?..?.....P.
124453	FF3F1000 3F0010FC FB000101 B0F85009	.....x..x..x..x
124457	00000700 03007800 78007800 78000000	.....P.....
124461	00000000 00000000 00001E00 06010000	.....#a.....
124465	48004000 FC001A00 6B74017C 23616974	.....P.....
124469	01BC2361 7F000100 01000000 FEF00000	.....Pp0.....
124473	00000000 00000000 00000000 B0F85009	b..9+.....
124477	00000000 00000000 00000000 01507051@..@.....
124481	62ED392E 00000000 00000000 00000000!.....
124485	00001C40 1C400000 00000000 00000000	.....
124489	00000000 21000000 00000000 00000000	.....
124493	00000000 00000000 00000000 00000000	.....
124497	00000000 00000000 00000000 00000000	.....
124501	00000000 00000000 00000000 00000000	.....
124505	00000000 00000000 00000000 00000000	.....
124509	00000000 00000100 00000000 00000000	.....
124513	00000000 00000000 00000000 00000000	.....
124517	00000000 00000000 00000000 00000000	.....
124521	00000000 00000000 00000000 00000000	.....
124524	00000000 00000000 00000000 00000000	.....
124528	00000000 00000000 00000000 00000000	.....
124532	00000000 00000000 00000000 00000000	.....
124536	00000000 00000100 00000000 00000000	.....
124540	1F100000 00000000 00000000 00000000	.....
124544	00000000 00000000 00000000 00000000	.....
124548	00000000 00000000 00000000 00000000	.....
124552	00000000 00000000 00000000 00000000	.....
124556	00000000 00000000 00000000 00000000	.....
124560	0000A52E E931B1FB	.....1..

Command Listing

Store #	Timestamp	Dir	L1-L4 Type
124,245	1.151179046 min	INIT	COMWAKE DOB
124,306	1.151179072 min	TRGT	COMWAKE DOB
124,346	1.151181072 min	TRGT	FIS 34 - Status: 0x50 - DRDY
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124,422	1.151328334 min	TRGT	FIS 46 - Payload Data
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124,596	1.151338564 min	TRGT	FIS 46 - Payload Data
124,747	1.151338609 min	TRGT	FIS 34 - Status: 0x50 - DRDY
124,765	1.151347777 min	INIT	FIS 27 - Device Control Registers Update
124,783	1.151347805 min	INIT	FIS 27 - Device Control Registers Update
124,803	1.151348277 min	TRGT	FIS 34 - Status: 0x50 - DRDY

0x0001 shows that spindle speed is that of SSD

- We've discussed the following:
 - Trim semantics and how a device can use it
 - How a device can report back that it wants to receive Trim information
 - How a device can report back that it should not be defragmented by default
- Windows 7 works well with SSDs
 - More work to be done in future versions of Windows

Questions?

Separator Slide