**To:**     **T10 Committee**
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**Subj:**  **Background Medium Scan**
**Date:**   **Dec. 8, 2004**

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This document proposes a standard method to control and retrieve status from background medium scan operations. Several drive vendors (including Seagate) have proprietary methods for controlling these operations today, but customers have asked that a standard method be defined so their processes can be simpler.

Many systems implement background medium scanning in their operating systems. Having the drive do the medium scanning instead has the advantage of reducing system overhead and removing an unproductive demand on interface bus bandwidth. During idle periods, the drive reads each sector on its medium to verify the data. If correctable errors are detected, the drive may rewrite and/or relocate the LBA to another sector depending on what has been allowed by the customer. Errors are logged to a list; if allowed by the customer, a future write to that LBA may result in the LBA being relocated before performing the write.

There is a related option called Pre-scan. This is a feature that starts a background medium scan right after power on. If the customer does a write operation to an area of the disk that has not been scanned yet, the drive turns the write operation into a write-and-verify operation. This has the advantage of checking (right after power on) that all data can be read back correctly. A disadvantage is that the drive's performance is reduced (because of the extra steps to do the verify operation) until the first medium scan is completed. Some customers choose to disable this option for that reason.

This proposal includes fields in a mode page that is used to control the scan and pre-scan operations. It also includes parameters in a log page that stores a list of LBAs that have or did have read errors. The system can read this list and may take action on LBAs that the drive was not able to handle on its own.

Editorial conventions – added text is underlined, deleted text is struck through, changes to tables are not specifically marked.

Rev. 1: Added wording for model section; added wording change for EBF bit in IEC mode page; added description for using Extended Control mode page (page 0xA, subpage 1) for the BMS mode page controls; added description to use Self-Test Results log page for returning BMS log data.

Rev. 2: Change to adding model, mode page, and log page to SBC; use IEC subpage 1 for the mode page; use log page 15h for the log page; other editorial fixes requested at Nov. 2004 CAP meeting.

**1.0 Changes to Information Exception Control mode page in SPC**

**7.4.11 Information Exceptions Control mode page**
[editors note: words describing everything but EBF bit are unchanged but not replicated here.]

If background functions are supported, an Enable Background Function (EBF) bit set to one indicates the device server shall enable background functions. An EBF bit set to zero indicates the device server shall disable the functions. Background functions with separate enable control bits are not controlled by this bit (e.g., see Background Control mode page in SBC).

For the purposes of the EBF bit, background functions are defined as idle time functions that may impact performance that are performed by a device server operating without errors but do not impact the reliability of the logical unit (e.g., read scan).

**2.0 Add background medium scan model in SBC**

**4.x Background medium read scan operations**

Medium scanning is when logical blocks are read from the medium for the purpose of verifying that the blocks are readable. The blocks are not retained in cache after they are read. The intent is to identify blocks that are difficult to read or unreadable, log the problem, and possibly take action to make the block easily readable again. This action increases the reliability of storing data in the device. A system can do this by sending read commands over the SCSI interface to access all logical blocks periodically, but this has the disadvantage of using system resources (e.g., SCSI interface bandwidth and initiator processing power) for an unproductive purpose. This disadvantage is removed by having the device do the scanning itself, during time when it is otherwise idle, without using any bandwidth on the SCSI interface.

If a block is readable but requires extra actions (e.g., retries or application of correction algorithm) to be read, the device may resolve the problem by rewriting the original data to the same physical location or relocating the logical block to another physical location.

If a block is unreadable the device cannot resolve the problem itself, but it may add that logical block to an internal list so it gets relocated the next time that logical block is written by an initiator.

The initiator still has control over whether to allow the device to correct the problem or to address the problem itself. The ARRE bit (see Read Write Error Recovery mode page) controls whether the device may automatically repair/ relocate recoverable read errors. The AWRE bit (also in the Read Write Error Recovery mode page) controls whether the device may relocate blocks during write operations. Blocks that have previously been logged as unrecoverable are reassigned at the start of the next write operation to that logical block. These bits control the device action during background medium scanning as well as during normal read and write operations.

**4.x.1 Enabling medium pre-scan operation**

The pre-scan feature is enabled by clearing, then setting the EN_PS bit in the Background Control mode page (see 6.3.x) and power cycling the device. After power is restored the pre-scan timer is set to zero and the device begins scanning the medium starting at LBA zero and ending with the last LBA. During this time any commands from an initiator will cause the pre-scan operation to be suspended while the device services the commands. The pre-scan operation will resume where it left off when all initiator commands have been completed.

Write commands may get special handling by the device. If a write command accesses an LBA that have not yet been scanned during the pre-scan operation, then it is converted into a write and verify command. This verifies that the data just written was read back successfully. If a write

command accesses an LBA that has already been scanned during the pre-scan operation then it is processed normally. All other commands are processed normally in either case.

### 4.x.2 Halting medium pre-scan operation

The pre-scan feature is halted when any of the following occurs:
   (a)  the pre-scan operation completes scanning all LBAs on the device;
   (b)  an initiator clears the EN_PS bit (see 6.3.x [refer to Background Control mode page]);
   (c)  the pre-scan timer reaches the Pre-scan Timeout Value (see 6.3.x [refer to Background Control mode page]);
   (d)  or the device detects an unusual pattern of errors.

Once the pre-scan is halted, it can only be restarted from the beginning (see 4.x.1).

### 4.x.3 Enabling background medium scan operation

If pre-scan operation is enabled, it shall be completed or halted before background medium scan operation is started. The background medium scan feature is enabled by setting the EN_BMS bit in the Background Control mode page (see 6.3.x). After the BMS Interval Time (see 6.3.x [refer to Background Control mode page]) has been satisfied, the device will begin scanning the medium starting at LBA zero and ending with the last LBA. During this time any commands from an initiator will cause the background medium scan operation to be suspended while the device services the commands. The background medium scan operation will resume where it left off when all initiator commands have been completed.

After the last LBA has been scanned, the BMS interval timer is set to 0 and the background medium scan operation becomes dormant until the BMS Interval Time is satisfied. Then the background medium scan operation starts another scanning cycle starting at LBA zero.

### 4.x.4 Suspending background medium scan operation

The background medium scan feature is suspended when any of the following occurs:
   (a)  the background medium scan operation completes scanning all LBAs on the device;
   (b)  an initiator clears the EN_BMS bit (see 6.3.x [refer to Background Control mode page]);
   (c)  or the device detects an unusual pattern of errors.

Once the background medium scan is suspended, it resumes from the spot where it left off when it is enabled again (see 4.x.3).

### 4.x.5 Interpreting the logged results

An initiator may poll the Background Scan Results log page (see 6.2.x) to get information about pre-scan and background medium scan activity. The BMS status parameter has fields that indicate whether a pre-scan or background medium scan is active or suspended, the number of scans performed on the medium, and the progress of a scan that is active. This information can be used by an initiator to monitor the background scanning operations.

The medium scan parameters, if any, describe the physical and logical location of any suspected defects.  The reassign status field indicates whether the defect was completely handled by the device or whether the initiator may have to take action (e.g., reassigning or re-writing an LBA) to fix a particular defect.

After an initiator analyzes the medium scan parameters and has completed actions, if any, to resolve the defects it may delete the list by issuing a LOG SELECT command with PCR bit set (see Log Select command in SPC). This eliminates the need to analyze the same entries at a later time.

**3.0 Add Background Control mode page in SBC**

**6.3.x Background Control mode page**

The Background Control mode page (see table new0) is a subpage of the Informational
Exception Control mode page (see SPC) and provides controls over background operations. The
mode page policy (see SPC) for this subpage shall be shared.

**Table new0 – Background Control mode page**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | PS | SPF(1b) | PAGE CODE (1Ch) | | | | | |
| 1 | SUBPAGE CODE (01h) | | | | | | | |
| 2 | (MSB) | PAGE LENGTH (001Ch) | | | | | | |
| 3 | | | | | | | | (LSB) |
| 4 | RESERVED | | | | | | | EN_PS |
| 5 | RESERVED | | | | | | | EN_BMS |
| 6 | (MSB) | BMS INTERVAL TIME | | | | | | |
| 7 | | | | | | | | (LSB) |
| 8 | (MSB) | PRE-SCAN TIMEOUT VALUE | | | | | | |
| 9 | | | | | | | | (LSB) |
| 10 | RESERVED | | | | | | | |
| 11 | RESERVED | | | | | | | |
| 12 | RESERVED | | | | | | | |
| 31 | | | | | | | | |

An enable pre-scan (EN_PS) bit set to zero specifies that pre-scan is disabled. If a pre-scan
operation is in progress when EN_PS is changed from a one to a zero then pre-scan is halted.
An EN_PS bit set to one specifies that a pre-scan operation is started after the next power on
cycle. Once this pre-scan has completed, another pre-scan shall not occur unless the EN_PS bit
is set to zero, then set to one, and another power on cycle occurs.

An enable background medium scan (EN_BMS) bit set to zero specifies that background medium
scan is disabled. An EN_BMS bit set to one specifies that background medium scan operations
are allowed. If the EN_PS bit is also set to one then a background medium scan operation will
not start until after the pre-scan operation is halted or completed. The BMS interval time shall
also be satisfied before a background medium scan operation is started. If a background medium
scan is in progress when the EN_BMS bit is changed from one to zero, then the medium scan is
suspended; when the EN_BMS bit is subsequently set to one, the medium scan shall resume
from the suspended location.

The BMS interval time field specifies the minimum time, in hours, between the end of one pre-
scan or background medium scan operation and the start of the next background medium scan
operation.

The pre-scan timeout value field specifies the maximum time, in hours, for a pre-scan operation
to complete. If the pre-scan operation doesn't complete within the specified time then it is halted.

**4.0 Add Background Scan Results log page in SBC**

**6.2.x Background Scan Results log page**

The Background Scan Results log page (see table new1) returns the BMS Status parameter and zero or more Medium Scan parameters when the background medium scan feature is implemented. The BMS Status parameter provides information about pre-scan and background medium scan operations. Each medium error log entry corresponds to a site where an error was detected. If the Medium Scan log area is filled up, a new medium scan log entry will overwrite the oldest entry. When a LOG SELECT command with PCR bit set to one is processed all Medium Scan parameters are deleted, but the values in the BMS Status Parameter are unaffected.

**Table new1 – Background Scan Results log page**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | PAGE CODE (15h) | | | | | | | |
| 1 | RESERVED | | | | | | | |
| 2 | (MSB) | | | PAGE LENGTH ($19+24_N-3$) | | | | |
| 3 | | | | | | | | (LSB) |
| | Background Medium Scan parameters | | | | | | | |
| 4<br><br>19 | BMS STATUS PARAMETER | | | | | | | |
| 20<br><br>43 | FIRST MEDIUM SCAN PARAMETER | | | | | | | |
| | $\vdots$<br>$\vdots$ | | | | | | | |
| 19 +<br>$24_N$ | LAST MEDIUM SCAN PARAMETER | | | | | | | |

[editors note: for N=2048 medium scan parameters, total number of bytes will be 49,172. This is comfortably within the maximum page length of 65,535.]
[editors note: descriptions of self-test results parameters are unchanged but not replicated here.]

### 6.2.x.1 BMS Status parameter

The background medium scan (BMS) status parameter (see table new2) contains status information about the background medium scan feature.

**Table new2 – BMS Status parameter format**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | (MSB) | | | PARAMETER CODE (0000h) | | | | |
| 1 | | | | | | | | (LSB) |
| 2 | DU | DS | TSD | ETC | TMC | | LBIN | LP |
| 3 | | | | PARAMETER LENGTH (0Ch) | | | | |
| 4 | (MSB) | | | | | | | |
| 5 | | | | POWER ON MINUTES | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | (LSB) |
| 8 | | | | RESERVED | | | | |
| 9 | | | | BMS STATUS | | | | |
| 10 | (MSB) | | | NUMBER OF SCANS PERFORMED | | | | |
| 11 | | | | | | | | (LSB) |
| 12 | (MSB) | | | MEDIUM SCAN PROGRESS | | | | |
| 13 | | | | | | | | (LSB) |
| 14 | | | | RESERVED | | | | |
| 15 | | | | | | | | |

The POWER ON MINUTES field indicates the total power on minutes at the time the log page is requested.

Table new3 specifies the meaning of the BMS STATUS field.

**Table new3 – BMS Status field**

| Value | Description |
|---|---|
| 0h | No scans active. |
| 1h | Background medium scan is active. |
| 2h | Pre-scan is active. |
| 3h | Scan suspended due to fatal error. |
| 4h | Scan suspended due to unusual pattern of errors. |
| 5h | Scan suspended due to medium formatted without P-List. |
| 6h | Scan suspended – vendor specific cause. |
| 7h | Scan suspended due to temperature out of allowed range. |
| 8h | Scan suspended until BMS Interval Time (see 6.3.x [refer to Background Control mode page]) expires. |
| 9h - FFh | Reserved |

The NUMBER OF SCANS PERFORMED field indicates the number of background scans that have been performed since the drive was originally shipped by the drive vendor.

The MEDIUM SCAN PROGRESS field is a percent complete indication in which the returned value is a numerator that has 65 536 (10000h) as its denominator.

### 6.2.x.2 Medium Scan parameter

A Medium Scan parameter (see table new4) describes a suspected defect location on the medium.

**Table new4 – Medium Scan parameter format**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | (MSB) | | PARAMETER CODE (0001h through 0800h) | | | | | |
| 1 | | | | | | | | (LSB) |
| 2 | DU | DS | TSD | ETC | TMC | | LBIN | LP |
| 3 | PARAMETER LENGTH (14h) | | | | | | | |
| 4 | (MSB) | | | | | | | |
| 5 | POWER ON MINUTES | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | (LSB) |
| 8 | REASSIGN STATUS | | | | SENSE KEY | | | |
| 9 | ADDITIONAL SENSE CODE | | | | | | | |
| 10 | ADDITIONAL SENSE CODE QUALIFIER | | | | | | | |
| 11 | HEAD NUMBER | | | | (MSB) | CYLINDER NUMBER | | |
| 14 | CYLINDER NUMBER | | | | | | | |
| 15 | | | | | | | | (LSB) |
| 14 | (MSB) | | SECTOR NUMBER | | | | | |
| 15 | | | | | | | | (LSB) |
| 16 | (MSB) | | | | | | | |
| 17 | | | | | | | | |
| 18 | LBA | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| 21 | | | | | | | | |
| 22 | | | | | | | | |
| 23 | | | | | | | | (LSB) |

The POWER ON MINUTES indicates the total power on minutes at the time the error was detected.

Table new5 specifies the meaning of the REASSIGN STATUS field.

**Table new5 – Reassign Status field**

| Value | Description |
|---|---|
| 0h | No reassignment needed. |
| 1h | Reassignment pending receipt of Reassign command or write command (if auto write reallocation is allowed) from the initiator. |
| 2h | LBA successfully reassigned by drive. |
| 3h | Reserved |
| 4h | Reassignment failed. |
| 5h | LBA recovered via re-write only. |
| 6h - Fh | Reserved |

The Sense Key, Additional Sense Code, and Additional Sense Code Qualifier fields are the same as the sense bytes (see sense data section of SPC). They indicate the sense bytes that would be reported for this site if the medium error were detected by a normal read or write. These sense

bytes are not reported by any other method because the error was detected during pre-scan or background scan.

The head number field indicates the head on which the medium error was detected.

The cylinder number field indicates the cylinder number associated with the medium error.

The sector number field indicates the sector number associated with the medium error.

The LBA field indicates the LBA associated with the medium error.