To: **T10 Committee**
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Subj: **Background Medium Scan**
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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 <u>underlined</u>, 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.

Rev. 3: Changes suggested during offline reviews.

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 a device server reads logical blocks from the medium for the purpose of identifying blocks that are difficult to read or unreadable, log any read problem, and optionally take a vendor specific action to make the block readable again. Background medium scanning means the operation is performed without using any bandwidth on the SCSI interface. The blocks shall not be retained in cache after they are read.

If a block is readable but requires extra actions (e.g., retries or application of correction algorithm) to be read, the device server may resolve the problem using vendor specific means. The ARRE bit (see Read Write Error Recovery mode page) controls whether the device server may automatically repair or relocate recoverable read errors.

If a block is unreadable the device server may note that the block is bad so it may be relocated. The AWRE bit (see Read Write Error Recovery mode page) controls whether the device server may relocate blocks during write operations. If allowed by AWRE setting, blocks that have previously been noted as unrecoverable are reassigned at the start of the next write operation to that logical block.

4.x.1 Enabling medium pre-scan operation

The pre-scan feature is enabled by setting the EN_PS bit in the Background Control mode page (see 6.3.x) to zero, then setting the EN_PS bit to one 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 application client shall cause the pre-scan operation to be suspended while the device server processes the commands. The pre-scan operation shall resume where it left off when all commands have been completed.

A write command that accesses an LBA that has not been scanned during the pre-scan operation 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]); or
(d) the device detects a vendor specific pattern of errors.

Once the pre-scan is halted, it shall restart at LBA zero (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 reached, the device shall begin scanning the medium starting at LBA zero and ending with the last LBA. During this scan any commands from an application client shall cause the background medium scan operation to be suspended while the device server processes the commands. The background medium scan operation shall resume where it left off when all initiator commands have been successfully completed (i.e., no ACA exists).

After the last LBA has been scanned, the BMS interval timer is set to zero and the background medium scan operation becomes dormant for a BMS Interval Time. Then the background medium scan operation starts another scanning cycle 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 sets the EN_BMS bit to zero (see 6.3.x [refer to Background Control mode page]); or
(c) the device detects a vendor specific pattern of errors.

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

4.x.5 Interpreting the logged results

An application client 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 may be used by an application client to monitor the background scanning operations.

The medium scan parameters, if any, describe the physical and logical location of any suspected bad blocks. The REASSIGN STATUS field indicates whether the defect was completely handled by the device server or whether the application client may have to take action (e.g., reassigning or re-writing an LBA) to fix a particular bad block.

After an application client analyzes the medium scan parameters and has completed actions, if any, to resolve the bad blocks, it may delete the log entries by issuing a LOG SELECT command with PCR bit set to one (see Log Select command in SPC).

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 Byte	7	6	5	4	3	2	1	0
0	PS	SPF(1b)	PAGE CODE (1Ch)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (000Ch)						
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							
15								

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 enabled. If the EN_PS bit is also set to one then a background medium scan operation shall not start until after the pre-scan operation is halted or completed. The BMS interval time shall occur 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 shall be suspended until the EN_BMS bit is set to one, at which time 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 does not 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 supported. The BMS Status parameter provides information about pre-scan and background medium scan operations. Each medium error log entry corresponds to a logical block where an error was detected. If the Medium Scan log area is filled up, a new medium scan log entry overwrites the oldest entry. When a LOG SELECT command with PCR bit set to one is processed all Medium Scan parameters are deleted, however the values in the BMS Status Parameter shall not be affected.

Table new1 – Background Scan Results log page

Bit / Byte	7	6	5	4	3	2	1	0
0	PAGE CODE (15h)							
1	RESERVED							
2	(MSB)			PAGE LENGTH (19+24N -3)				
3								(LSB)
	Background Medium Scan parameters							
4 · · 19	BMS STATUS PARAMETER							
20 · · 43	FIRST MEDIUM SCAN PARAMETER							
	: :							
19 + 24N	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.]

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 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 halted due to fatal error.
4h	Scan halted due to unusual pattern of errors.
5h	Scan halted due to medium formatted without P-List.
6h	Scan halted – vendor specific cause.
7h	Scan halted 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 manufacturer.

The MEDIUM SCAN PROGRESS field is a percent complete indication of the medium scan. 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 defect location on the medium.

Table new4 – Medium Scan parameter format

Byte \ Bit	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.
6h - Fh	Reserved

The Sense Key, Additional Sense Code, and Additional Sense Code Qualifier fields have the same meaning as the sense bytes (see sense data section of SPC).

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.