To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 17 July 2006
Subject: 06-320r1 SPC-4 Statistics logging for FUA and FUA_NV

Revision history
Revision 0 (6 July 2006) First revision
Revision 1 (17 July 2006) Incorporated comments from July 2006 CAP WG

Related documents
spc4r05a - SCSI Primary Commands - 4 (SPC-4) revision 5a
05-248r4 Statistics and Performance log pages (George Penokie, IBM) - incorporated into spc4r05a

Overview
A read or write command with the force unit access (FUA) bit set to one can take significantly longer to process than a command with the FUA bit set to zero. Statistics for those commands should be kept separately in the Statistics and Performance log pages recently added to SPC-4.

Commands with the force unit access nonvolatile (FUA_NV) bit can take significantly longer to process if the logical unit has no non-volatile cache memory but take no additional time if it has non-volatile cache memory. Since the behavior varies from that of commands with the FUA bit set to one, they are proposed to be counted separately.

Both number of commands and command processing time are counted; weighted versions are not proposed. Only commands with FUA or FUA_NV bits are counted, not commands like WRITE AND VERIFY that perform implicit force unit accesses.

Suggested changes to SPC-4

7.2.12 Statistics and Performance log pages

7.2.12.1 Statistics and Performance log pages overview

The Statistics and Performance log pages consist of a General Statistics and Performance log page and up to 31 Group Statistics and Performance log pages. Each Group Statistics and Performance log pages only collects statistics and performance information for the group number specified in a read CDB or a write CDB.

The General Statistics and Performance log page (see 7.2.12.2) provides the following statistics and performance results associated to the addressed logical unit:

    a)   Number of read commands;
    b)   Number of write commands;
    c)   Number of read logical blocks transmitted by a target port;
    d)   Number of write logical blocks received by a target port;
    e)   Read command processing time;
    f)   Write command processing time;
    g)   Sum of the command weights of the read commands plus write commands;
    h)   Sum of the weighted command time of the read commands plus write commands;
    i)   Idle time; and
    j)   Time interval.

The Group Statistics and Performance log pages (see 7.2.12.3) provide the following statistics and performance results associated to the addressed logical unit and the GROUP NUMBER field:

    a)   Number of read commands;
    b)   Number of write commands;
    c)   Number of read logical blocks transmitted by a target port;
    d)   Number of write logical blocks received by a target port;
    e)   Read command processing time; and
    f)   Write command processing time.

In the Statistics and Performance log pages, read and write commands are those shown in table 235.

Table 235 — Statistics and Performance log pages read and write commands

Read commands	Write commands
READ(6) READ(10) READ(12) READ(16) READ(32) READ CD READ CD MSF READ REVERSE(16) XDREAD(10) XDREAD(32)	WRITE(6) WRITE(10) WRITE(12) WRITE(16) WRITE(32) WRITE AND VERIFY(10) WRITE AND VERIFY(12) WRITE AND VERIFY(16) WRITE AND VERIFY(32) XDWRITE(10) XDWRITE(32)

7.2.12.2 General Statistics and Performance log page

7.2.12.2.1 General Statistics and Performance log page overview

Table 236 shows the General Statistics and Performance log page format.

Table 236 — General Statistics and Performance log page

Byte\Bit	7	6	5	4	3	2	1	0
0	DS	SPF (0b)	PAGE CODE (19h)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (5Ch7Ch)						
3								(LSB)
	General Statistics and Performance log parameters							
4	Statistics and Performance log parameter (see table 237 in 7.2.12.2.2)							
71								
72	Idle Time log parameter (see table 239 in 7.2.12.2.3)							
83								
84	Time Interval log parameter (see table 240 in 7.2.12.2.4)							
95								
96	Force Unit Access Statistics and Performance log parameter, if any (see table 241 in 7.2.12.2.5)							
159								

The DS bit, SPF bit, PAGE CODE field, SUBPAGE CODE field, and PAGE LENGTH field are described in 7.2.1.

Table 237 defines the log parameters for the Statistics and Performance log page.

Table 237 — Statistics and Performance log parameters

Parameter code	Name	Type	Reference
0001h	Statistics and Performance	Required	7.2.12.2.2
0002h	Idle Time	Required	7.2.12.2.3
0003h	Time Interval	Required	7.2.12.2.4
0004h	Force Unit Access Statistics and Performance	Optional	7.2.12.2.5
All others	Reserved		

7.2.12.2.2 Statistics and Performance log parameter

Table 237 shows the Statistics and Performance log parameter format.

Table 238 — Statistics and Performance log parameter

Byte\Bit	7	6	5	4	3	2	1	0
0	(MSB)			PARAMETER CODE (0001h)				
1								(LSB)
2	DU	Obsolete	TSD	ETC	TMC		FORMAT AND LINKING	
3	PARAMETER LENGTH (40h)							
4	(MSB)			NUMBER OF READ COMMANDS				
11								(LSB)
12	(MSB)			NUMBER OF WRITE COMMANDS				
10								(LSB)
20	(MSB)			NUMBER OF LOGICAL BLOCKS RECEIVED BY A TARGET PORT				
27								(LSB)
28	(MSB)			NUMBER OF LOGICAL BLOCKS TRANSMITTED BY A TARGET PORT				
35								(LSB)
36	(MSB)			READ COMMAND PROCESSING INTERVALS				
43								(LSB)
44	(MSB)			WRITE COMMAND PROCESSING INTERVALS				
51								(LSB)

Table 238 — Statistics and Performance log parameter

Byte\Bit	7	6	5	4	3	2	1	0
52	(MSB)							
			WEIGHTED NUMBER OF READ COMMANDS PLUS WRITE COMMANDS					
59								(LSB)
60	(MSB)		WEIGHTED READ COMMAND PROCESSING PLUS WRITE COMMAND					
			PROCESSING					
67								(LSB)

The PARAMETER CODE field set to 0001h identifies the log parameter being transferred as the Statistics and Performance log parameter.

The values of the log parameter control bits and fields for the log parameters in the Statistics and Performance log parameter are as specified in table 238.

Table 239 — Parameter control bits for the Statistics Andand Performance log page parameters

Bit or field	Value	Description
DU	0b	Value provided by device server
TSD	0b	Device server manages saving of parameter
ETC	0b	No threshold comparison is made on this value
TMC	xx	Ignored when the etc bit is set to zero
FORMAT AND LINKING	10b	If another parameter reported in this log page reaches its maximum value, then this parameter shall not stop incrementing. This parameter may be reinitialized by aLOG SELECT command.

The PARAMETER LENGTH field specifies the length in bytes of the statistics and performance fields that follow.

The NUMBER OF READ COMMANDS field contains the number of read commands (see 7.2.12.1) received by the logical unit.

The NUMBER OF WRITE COMMANDS field contains the number of write commands (see 7.2.12.1) received by the logical unit.

The NUMBER OF LOGICAL BLOCKS RECEIVED BY A TARGET PORT field contains the number of logical blocks received from the service delivery subsystem for the device server of the logical unit as a result of write commands (see 7.2.12.1).

The NUMBER OF LOGICAL BLOCKS TRANSMITTED BY A TARGET PORT field contains the number of logical blocks delivered to the service delivery subsystem by the device server of the logical unit as a result of read commands (see 7.2.12.1).

The READ COMMAND PROCESSING INTERVALS field contains the cumulative number of time intervals (see table 240 in 7.2.12.2.4) spent by the logical unit processing read commands (see 7.2.12.1) by the logical unit.

The WRITE COMMAND PROCESSING INTERVALS field contains the cumulative number of time intervals (see table 240 in 7.2.12.2.4) spent by the logical unit processing write commands (see 7.2.12.1) by the logical unit.

If task priority is supported (see SAM-4), then the WEIGHTED NUMBER OF READ COMMANDS PLUS WRITE COMMANDS field contains the cumulative command weight of the read commands and write commands (see 7.2.12.1) processed by the logical unit.

Command weight is calculated as follows:

    command weight = (360 360 ÷ task priority)

where:

task priority is as defined in SAM-4. However, if the computed task priority is zero, then the task priority shall be set to seven (i.e., a mid-range task priority value).

If task priority is not supported, then the WEIGHTED NUMBER OF READ COMMANDS PLUS WRITE COMMANDS field shall be set to zero.

If task priority is supported (see SAM-4), then the WEIGHTED READ COMMAND PROCESSING PLUS WRITE COMMAND PROCESSING field contains the cumulative weighted command time of the time intervals (see table 240 in 7.2.12.2.4) spent processing read commands and write commands (see 7.2.12.1) by the logical unit.

Weighted command time is calculated as follows:

weighted command time = (time increments processing the command × time interval) × (360 360 ÷ task priority)

where:

time increments processing a command is the number of time intervals from the time the task manager places the command into a task set until the device server sends a SCSI transport protocol service response for the command;
time interval is the value represented in the TIME INTERVAL DESCRIPTOR field of the Time Interval log parameter (see table 240 in 7.2.12.2.4), and
task priority is as defined in SAM-4. However, if the computed task priority is zero, then the task priority time shall be set to seven (i.e., a mid-range task priority value).

If task priority is not supported, then the WEIGHTED READ COMMAND PROCESSING PLUS WRITE COMMAND PROCESSING field shall be set to zero.

7.2.12.2.3 Idle Time log parameter

Table 239 shows the Idle Time log parameter format.

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The PARAMETER CODE field set to 0002h identifies the log parameter being transferred as the Idle Time log parameter.

The values of the log parameter control bits and fields for the Idle Time log parameter are as specified in table 238 in 7.2.12.2.2.

The PARAMETER LENGTH field specifies the length in bytes of the IDLE TIME INTERVALS field that follows.

The IDLE TIME INTERVALS field contains the cumulative number of idle times spent when there are no tasks in the task set and there are no tasks being processed by the logical unit.

Idle time is calculated as follows:

idle time = (time increments not processing commands × time interval)

where:

time increments not processing commands is the number of time intervals when there are no commands in the task set and the device server has sent a SCSI transport protocol service response for all commands being processed (i.e., there are no commands to be processed or being processed); and
time interval is the value represented in the time interval descriptor of the Time Interval log parameter (see table 240 in 7.2.12.2.4).

7.2.12.2.4 Time Interval log parameter

Table 240 shows the Time Interval log parameter format.

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The PARAMETER CODE field set to 0003h identifies the log parameter being transferred as the Time Interval log parameter.

The values of the log parameter control bits and fields for the Time Interval log parameter are as specified in table 238 in 7.2.12.2.2.

The PARAMETER LENGTH field specifies the length in bytes of the IDLE TIME INTERVALS field that follows.

The time interval descriptor (see table 241) contains the time interval in seconds used in ~~the READ COMMAND PROCESSING TIME field (see table 237), the WRITE COMMAND PROCESSING TIME field (see table 237), the WEIGHTED READ COMMAND PROCESSING PLUS WRITE COMMAND PROCESSING field (see table 237), and the IDLE TIME INTERVALS field (see table 239)~~ various time interval fields in the General Statistics and Performance log parameter (see 7.2.12.2.2) and the Force Unit Access Statistisc and Performance log parameter (see 7.2.12.2.5).

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7.2.12.2.5 Force Unit Access Statistics and Performance log parameter

Table 241 shows the Force Unit Access Statistics and Performance log parameter format.

Table 241 — Force Unit Access Statistics and Performance log parameter

Byte\Bit	7	6	5	4	3	2	1	0
0	(MSB)							
1				PARAMETER CODE (0004h)				(LSB)
2	DU	Obsolete	TSD	ETC	TMC		FORMAT AND LINKING	
3				PARAMETER LENGTH (40h)				
4	(MSB)							
11				NUMBER OF READ FUA COMMANDS				(LSB)
12	(MSB)							
10				NUMBER OF WRITE FUA COMMANDS				(LSB)
20	(MSB)							
27				NUMBER OF READ FUA_NV COMMANDS				(LSB)
28	(MSB)							
35				NUMBER OF WRITE FUA_NV COMMANDS				(LSB)
36	(MSB)							
43				READ FUA COMMAND PROCESSING INTERVALS				(LSB)
44	(MSB)							
51				WRITE FUA COMMAND PROCESSING INTERVALS				(LSB)
52	(MSB)							
59				READ FUA_NV COMMAND PROCESSING INTERVALS				(LSB)
60	(MSB)							
67				WRITE FUA_NV COMMAND PROCESSING INTERVALS				(LSB)

The PARAMETER CODE field set to 0004h identifies the log parameter being transferred as the Force Unit Access Statistics and Performance log parameter.

The values of the log parameter control bits and fields for the Force Unit Access Statistics and Performance log parameter are as specified in table 238 in 7.2.12.2.2.

The PARAMETER LENGTH field specifies the length in bytes of the statistics and performance fields that follow.

The NUMBER OF READ FUA COMMANDS field contains the number of read commands (see 7.2.12.1) with the FUA bit set to one received by the logical unit.

The NUMBER OF WRITE FUA COMMANDS field contains the number of write commands (see 7.2.12.1) with the FUA bit set to one received by the logical unit.

The NUMBER OF READ FUA_NV COMMANDS field contains the number of read commands (see 7.2.12.1) with the FUA_NV bit set to one received by the logical unit.

The NUMBER OF WRITE FUA_NV COMMANDS field contains the number of write commands (see 7.2.12.1) with the FUA_NV bit set to one received by the logical unit.

Editor's Note 1: An application can calculate the number of commands that had both FUA=0 and FUA_NV=0 using: (NUMBER OF READ COMMANDS - NUMBER OF READ FUA COMMANDS - NUMBER OF READ FUA_NV COMMANDS)

The READ FUA COMMAND PROCESSING INTERVALS field contains the cumulative number of time intervals (see table 240 in 7.2.12.2.4) spent by the logical unit processing read commands (see 7.2.12.1) with the FUA bit set to one.

The WRITE FUA COMMAND PROCESSING INTERVALS field contains the cumulative number of time intervals (see table 240 in 7.2.12.2.4) spent by the logical unit processing write commands (see 7.2.12.1) with the FUA bit set to one.

The READ FUA_NV COMMAND PROCESSING INTERVALS field contains the cumulative number of time intervals (see table 240 in 7.2.12.2.4) spent by the logical unit processing read commands (see 7.2.12.1) with the FUA_NV bit set to one.

The WRITE FUA_NV COMMAND PROCESSING INTERVALS field contains the cumulative number of time intervals (see table 240 in 7.2.12.2.4) spent by the logical unit processing write commands (see 7.2.12.1) with the FUA_NV bit set to one.

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7.2.12.3 Group Statistics and Performance (n) log page

7.2.12.3.1 Group Statistics and Performance (n) log page overview

The Group Statistics and Performance (n) log pages (see table 242) provide logging of statistics and performance of read and write operations based on group numbers. There are 31 Group Statistics and Performance (n) log pages one for each group number. The statistics and performance information associated with each group number is collected in the corresponding Group Statistics and Performance (n) log page (e.g.,

operations associated with group number 16 are logged in the Group Statistics and Performance (16) log page).

Table 242 — Group Statistics and Performance log page

Byte\Bit	7	6	5	4	3	2	1	0
0	DS	SPF (1b)	PAGE CODE (19h)					
1	SUBPAGE CODE (01h - 1Fh)							
2	(MSB)		PAGE LENGTH (~~34h~~74h)					
3								(LSB)
	Group Statistics and Performance log parameters							
4	Group n Statistics and Performance log parameter							
55	(see table 244 in 7.2.12.3.2)							
56	Group n Force Unit Access Statistics and Performance log parameter							
~~55~~119	(see table 245 in 7.2.12.3.3)							

The DS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field are described in 7.2.1.

The SUBPAGE CODE field is described in table 243.

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Table 237 defines the log parameters for the Group Statistics and Performance log page.

Table 243 — Group Statistics and Performance log parameters

Parameter code	Name	Type	Reference
0001h	Group n Statistics and Performance	Required	7.2.12.3.2
0004h	Group n Force Unit Access Statistics and Performance	Optional	7.2.12.3.3
All others	Reserved		

7.2.12.3.2 Group n Statistics and Performance log parameter

Table 244 shows the format of Group n Statistics and Performance log parameter.

Table 244 — Group n Statistics and Performance log parameter (part 1 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
0	(MSB)		PARAMETER CODE (0001h)					
1								(LSB)
2	DU	Obsolete	TSD	ETC	TMC		FORMAT AND LINKING	
3	PARAMETER LENGTH (30h)							

Table 244 — Group n Statistics and Performance log parameter (part 2 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
4	(MSB)							
11		GROUP N NUMBER OF READ COMMANDS						(LSB)
12	(MSB)							
19		GROUP N NUMBER OF WRITE COMMANDS						(LSB)
20	(MSB)							
27		GROUP N NUMBER OF LOGICAL BLOCKS RECEIVED BY A TARGET PORT						(LSB)
28	(MSB)							
35		GROUP N NUMBER OF LOGICAL BLOCKS TRANSMITTED BY A TARGET PORT						(LSB)
36	(MSB)							
43		GROUP N READ COMMAND PROCESSING TIME						(LSB)
44	(MSB)							
51		GROUP N WRITE COMMAND PROCESSING TIME						(LSB)

The PARAMETER CODE field set to 0001h identifies the log parameter being transferred as the Group n Statistics and Performance log parameter.

The values of the log parameter control bits and fields for the Group n Statistics and Performance log parameter are specified in table 238 in 7.2.12.2.

The PARAMETER LENGTH field specifies the length in bytes of the group n statistics and performance parameters that follow.

The GROUP N NUMBER OF READ COMMANDS field contains the number of read commands (see 7.2.12.1) received by the logical unit.

The GROUP N NUMBER OF WRITE COMMANDS field contains the number of write commands (see 7.2.12.1) received by the logical unit.

The GROUP N NUMBER OF LOGICAL BLOCKS RECEIVED BY A TARGET PORT field contains the number of logical blocks received from the service delivery subsystem for the device server of the logical unit as a result of write commands (see 1.1.2.17.2.12.1).

The GROUP N NUMBER OF LOGICAL BLOCKS TRANSMITTED BY A TARGET PORT field contains the number of logical blocks delivered to the service delivery subsystem by the device server of the logical unit as a result of read commands (see 1.1.2.17.2.12.1).

The GROUP N READ COMMAND PROCESSING TIME field contains the cumulative number of time intervals spent by the logical unit processing read commands by the logical unit (see 1.1.2.17.2.12.1). Time intervals are defined in the Time Interval log parameter (see table 240 in 7.2.12.2.4) in the General Statistics and Performance log page (see 7.2.12.2).

The GROUP N WRITE COMMAND PROCESSING TIME field contains the cumulative number of time intervals spent by the logical unit processing write commands by the logical unit (see 1.1.2.17.2.12.1). Time intervals are defined in the Time Interval log parameter (see table 240 in 7.2.12.2.4) in the General Statistics and Performance log page (see 7.2.12.2).

7.2.12.3.3 Group n Force Unit Access Statistics and Performance log parameter

Table 245 shows the format of Group n Force Unit Access Statistics and Performance log parameter.

Table 245 — Group n Force Unit Access Statistics and Performance log parameter

Byte\Bit	7	6	5	4	3	2	1	0
0	(MSB)			PARAMETER CODE (0004h)				
1								(LSB)
2	DU	Obsolete	TSD	ETC	TMC		FORMAT AND LINKING	
3				PARAMETER LENGTH (40h)				
4	(MSB)			GROUP N NUMBER OF READ FUA COMMANDS				
11								(LSB)
12	(MSB)			GROUP N NUMBER OF WRITE FUA COMMANDS				
19								(LSB)
20	(MSB)			GROUP N NUMBER OF READ FUA_NV COMMANDS				
27								(LSB)
28	(MSB)			GROUP N NUMBER OF WRITE FUA_NV COMMANDS				
35								(LSB)
36	(MSB)			GROUP N READ FUA COMMAND PROCESSING TIME				
43								(LSB)
44	(MSB)			GROUP N WRITE FUA COMMAND PROCESSING TIME				
51								(LSB)
52	(MSB)			GROUP N READ FUA_NV COMMAND PROCESSING TIME				
59								(LSB)
60	(MSB)			GROUP N WRITE FUA_NV COMMAND PROCESSING TIME				
67								(LSB)

The PARAMETER CODE field set to 0004h identifies the log parameter being transferred as the Group n Force Unit Access Statistics and Performance log parameter.

The values of the log parameter control bits and fields for the Group n Force Unit Access Statistics and Performance log parameter are specified in table 238 in 7.2.12.2.

The PARAMETER LENGTH field specifies the length in bytes of the statistics and performance fields that follow.

The GROUP N NUMBER OF READ FUA COMMANDS field contains the number of read commands (see 7.2.12.1) with the FUA bit set to one received by the logical unit.

The GROUP N NUMBER OF WRITE FUA COMMANDS field contains the number of write commands (see 7.2.12.1) with the FUA bit set to one received by the logical unit.

The GROUP N NUMBER OF READ FUA_NV COMMANDS field contains the number of read commands (see 7.2.12.1) with the FUA_NV bit set to one received by the logical unit.

The GROUP N NUMBER OF WRITE FUA_NV COMMANDS field contains the number of write commands (see 7.2.12.1) with the FUA_NV bit set to one received by the logical unit.

The GROUP N READ FUA COMMAND PROCESSING TIME field contains the cumulative number of time intervals spent by the logical unit processing read commands (see 7.2.12.1) with the FUA bit set to one. Time intervals are defined in the Time Interval log parameter (see table 240 in 7.2.12.2.4) in the General Statistics and Performance log page (see 7.2.12.2).

The GROUP N WRITE FUA COMMAND PROCESSING TIME field contains the cumulative number of time intervals spent by the logical unit processing write commands (see 7.2.12.1) with the FUA bit set to one. Time intervals are defined in the Time Interval log parameter (see table 240 in 7.2.12.2.4) in the General Statistics and Performance log page (see 7.2.12.2).

The GROUP N READ FUA_NV COMMAND PROCESSING TIME field contains the cumulative number of time intervals spent by the logical unit processing read commands (see 7.2.12.1) with the FUA_NV bit set to one. Time intervals are defined in the Time Interval log parameter (see table 240 in 7.2.12.2.4) in the General Statistics and Performance log page (see 7.2.12.2).

The GROUP N WRITE FUA_NV COMMAND PROCESSING TIME field contains the cumulative number of time intervals spent by the logical unit processing write commands (see 7.2.12.1) with the FUA_NV bit set to one. Time intervals are defined in the Time Interval log parameter (see table 240 in 7.2.12.2.4) in the General Statistics and Performance log page (see 7.2.12.2).