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To: T10 Committee (SCSI)

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Subject: SPC-4: Deferred Microcode Downloads

1 Overview

Downloading new microcode onto SCSI devices requires a foreground process that can take 20-50 seconds per device. All I/O activity to the device must halt until this process has completed. With large storage arrays that have dozens of devices, the process of installing new firmware can take over one hour of downtime on a large subsystem.

This proposal describes a concept in which the microcode is saved in nonvolatile storage as deferred microcode; when the subsystems I/O activity is low, the application client issues a command to each device to complete the microcode download process.

1.1 WRITE BUFFER command

1.1.1 WRITE BUFFER command introduction

The WRITE BUFFER command (see table 1) is used in conjunction with the READ BUFFER command as a diagnostic function for testing logical unit memory in the SCSI target device and the integrity of the service delivery subsystem. Additional modes are provided for:

- a) Downloading microcode;
- b) Downloading and saving microcode;
- a) [Downloading and deferring microcode](#); and
- c) Downloading application logs (see 5.12).

Table 1 — WRITE BUFFER command

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (3Bh)							
1	Reserved			MODE				
2	BUFFER ID							
3	(MSB) _____							
5	BUFFER OFFSET _____ (LSB)							
6	(MSB) _____							
8	PARAMETER LIST LENGTH _____ (LSB)							
9	CONTROL							

This command shall not alter any medium of the logical unit when the data mode or the combined header and data mode is specified.

The function of this command and the meaning of fields within the CDB depend on the contents of the MODE field. The MODE field is defined in table 2.

Table 2 — WRITE BUFFER MODE field

MODE	Description
00h	Write combined header and data ^a
01h	Vendor specific ^a
02h	Write data
04h	Download microcode
05h	Download microcode and save
06h	Download microcode with offsets ^b
07h	Download microcode with offsets and save ^b
0Ah	Echo buffer
0Dh	Download microcode and defer save
0Eh	Save deferred microcode
0Fh	Download microcode with offsets and defer save ^b
1Ah	Enable expander communications protocol and Echo buffer
1Bh	Disable expander communications protocol
1Ch	Download application log
03h	Reserved
08h - 09h	Reserved
0Bh - 0Ch	Reserved
10h - 19h	Reserved
0Bh - 19h	Reserved
1Dh - 1Fh	Reserved
^a Modes 00h and 01h are not recommended. ^b When downloading microcode with buffer offsets, the WRITE BUFFER command mode should be 06h, or 07h, or 0Fh .	

1.1.2 Combined header and data mode (00h)

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1.1.3 Vendor specific mode (01h)

...

1.1.4 Data mode (02h)

...

1.1.5 Download microcode mode (04h)

...

1.1.6 Download microcode and save mode (05h)

....

1.1.7 Download microcode with offsets mode (06h)

...

1.1.8 Download microcode with offsets and save mode (07h)

...

1.1.9 Write data to echo buffer mode (0Ah)

...

1.1.10 Download microcode and defer save mode (0Dh) [\(new subclause\)](#)

In this mode, vendor specific microcode or control information shall be transferred to the logical unit and, if the WRITE BUFFER command is completed successfully (i.e., the logical unit has verified the integrity of the microcode or control information in a vendor specific manner), then the microcode or control information shall be saved in a nonvolatile memory space (e.g., semiconductor, disk, or other) not associated with the current operational code. The deferred downloaded code shall not replace the current operational code until one of the following occurs:

- a) power on;
- b) START STOP UNIT command (see SBC-3);
- c) FORMAT UNIT command (see SBC-3); or
- d) WRITE BUFFER command specifying a save deferred microcode mode (0Eh) (see 1.1.11).

If a WRITE BUFFER command is received specifying a:

- a) download microcode mode (04h);
- b) download microcode and save mode (05h);
- c) download microcode with offsets mode (06h);
- d) download microcode with offsets and save mode (07h);
- e) download microcode and defer save mode (0Dh); or
- f) download microcode with offsets and defer save mode (0Fh),

then any deferred microcode or control information (i.e., saved microcode or control information that has not replaced operation code) shall be deleted.

After the deferred downloaded code replaces the current operational code, the downloaded microcode or control information shall be effective after each hard reset until it is supplanted in another:

- a) download microcode and save operation;
- b) download microcode with offsets and save operation;
- c) download microcode and defer save operation after the deferred downloaded code has replaced the current operation code; or
- d) download microcode with offsets and defer save operation after the deferred downloaded code has replaced the current operation code.

The meanings of the buffer id, buffer offset, and parameter list length fields are not specified by this standard and are not required to be zero-filled. When the download microcode has successfully replaced the current operational code the device server shall establish a unit attention condition (see SAM-4) with every I_T nexus with the additional sense code set to MICROCODE HAS BEEN CHANGED.

If the logical unit is unable to accept this command because of some device condition, each WRITE BUFFER command with this mode (0Dh) shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to COMMAND SEQUENCE ERROR.

1.1.11 Save deferred microcode mode (0Eh) [\(new subclause\)](#)

In this mode, deferred microcode or control information shall be saved in a nonvolatile memory space (e.g., semiconductor, disk, or other). The downloaded code shall then be effective after each hard reset until it is

supplanted in another download microcode and save operation or download microcode with offsets and save operation. Any deferred microcode or control information shall be deleted.

After the deferred downloaded code replaces the current operational code, the downloaded microcode or control information shall be effective after each hard reset until it is supplanted in another:

- a) download microcode and save operation;
- b) download microcode with offsets and save operation;
- c) download microcode and defer save operation after the deferred downloaded code has replaced the current operation code; or
- d) download microcode with offsets and defer save operation after the deferred downloaded code has replaced the current operation code.

The meanings of the buffer id, buffer offset, and parameter list length fields are not specified by this standard and are not required to be zero-filled. When the download microcode has successfully replaced the current operational code the device server shall establish a unit attention condition (see SAM-4) with every I_T nexus with the additional sense code set to MICROCODE HAS BEEN CHANGED.

If the logical unit is unable to accept this command because there is no deferred microcode or control information, it shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to COMMAND SEQUENCE ERROR.

1.1.12 Download microcode with offsets and defer save mode (0Fh) [\(new subclause\)](#)

In this mode, the application client may split the transfer of the vendor specific microcode or control information over two or more WRITE BUFFER commands. If the last WRITE BUFFER command of a set of one or more commands completes successfully, then the microcode or control information shall be saved in a nonvolatile memory space (e.g., semiconductor, disk, or other) not associated with the current operational code. Since the downloaded microcode or control information may be sent using several commands, when the logical unit detects the last download microcode with offsets and defer save mode WRITE BUFFER command has been received, the device server shall perform any logical unit required verification of the complete set of downloaded microcode or control information prior to returning GOOD status for the last command.

The deferred downloaded code shall not replace the current operational code until one of the following occurs:

- a) power on;
- b) START STOP UNIT command (see SBC-3);
- c) FORMAT UNIT command (see SBC-3); or
- d) WRITE BUFFER command with save deferred microcode mode (0Eh) (see 1.1.11).

After the deferred downloaded code replaces the current operational code, the device server shall establish a unit attention condition (see SAM-4) with every I_T nexus, with the additional sense code set to MICROCODE HAS BEEN CHANGED.

If the complete set of WRITE BUFFER commands required to effect a microcode or control information change (i.e., one or more commands) are not received before a logical unit reset or I_T nexus loss occurs, the save shall not be effective and the new microcode or control information shall be discarded.

If a WRITE BUFFER command is received with a:

- a) download microcode mode (04h);
- b) download microcode and save mode (05h);
- c) download microcode with offsets mode (06h);
- d) download microcode with offsets and save mode (07h); or
- e) download microcode and defer save mode (0Dh),

then any deferred microcode or control information (i.e., saved microcode or control information that has not replaced operation code) shall be deleted.

After the deferred downloaded code replaces the current operational code, the downloaded microcode or control information shall be effective after each hard reset until it is supplanted in another:

- a) download microcode and save operation;

- b) download microcode with offsets and save operation;
- c) download microcode and defer save operation after the deferred downloaded code has replaced the current operation code; or
- d) download microcode with offsets and defer save operation after the deferred downloaded code has replaced the current operation code.

The buffer id field specifies a buffer within the logical unit. The vendor assigns buffer ID codes to buffers within the logical unit. A buffer ID value of zero shall be supported. If more than one buffer is supported, then additional buffer ID codes shall be assigned contiguously, beginning with one. If an unsupported buffer ID code is specified, the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

The microcode or control information are written to the logical unit buffer starting at the location specified by the buffer offset field. The application client shall conform to the offset boundary requirements. If the device server is unable to accept the specified buffer offset, the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

The parameter list length field specifies the maximum number of bytes that shall be present in the Data-Out Buffer to be stored in the specified buffer beginning at the buffer offset. The application client should ensure that the parameter list length plus the buffer offset does not exceed the capacity of the specified buffer. The capacity of the buffer is indicated by the buffer capacity field in the READ BUFFER descriptor (see 6.15.5). If the buffer offset and parameter list length fields specify a transfer in excess of the buffer capacity, then the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

If the logical unit is unable to accept this command because of some device condition, each WRITE BUFFER command with this mode (0Fh) shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to COMMAND SEQUENCE ERROR.