

April 19, 1998



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Chairperson, X3T10
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Subject: Proposal for Enclosure Services Interface implementation

Dear Mr. Chairperson:

A broad class of SCSI device enclosures now provide significant internal intelligence to monitor the state of the power supplies, fans, and external switches as well as to set the state of reconfiguration circuits and indicators. In the Small Form Factor committee definitions for single connector attachment SCSI and Fibre Channel drives, these enclosure services can be accessed across the SCA connector using SCSI commands. In other implementations, the enclosure may actually provide a special target that performs these services. In accordance with the recommendations of the committee in the September 1995 working group meeting, I am proposing a set of functions and commands and a device model to allow access to enclosure services. This proposal will require the assignment of a new SCSI device type and a new mode select/sense page.

Sincerely,

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Enclosure Services proposal

1 Description of Enclosure Services Interface and proposal:

1.1 Overview

Using SCSI-3 technologies, disk drives and other SCSI devices may reside in subsystem enclosures some distance from the host initiators. To maintain a single communication interface with the host computer, it is important that any status information in the subsystem enclosure be available through the same SCSI interface that provides communications with the SCSI devices inside the enclosure. In addition, indicators, locks, and displays on the subsystem must be managed by the host through the SCSI interface. Very simple enclosures may make this information available through special ports to the standard SCSI devices. An example of such a port is the Enclosure Service Interface defined for SCA-2 attached devices by the Small Form Factor documents SFF-8045, SFF-8047, and SFF-8048. More sophisticated enclosures may actually create a special logical unit with its own or a shared target id that provides only enclosure services. While the method of accessing and setting such data is specified by this proposal, the actual data is mostly vendor unique, since the configuration and capabilities of each enclosure is unique. Some standard summary bits are defined for the convenience of monitoring software.

The SCSI-3 Controller Commands (SCC) document defines a MAINTENANCE IN and a MAINTENANCE OUT command. This command is not used for enclosure services because it is particular to the SCC model.

1.2 Enclosure Services capabilities

Enclosure services can be implemented as a component of a standard SCSI device or as a separate LUN. The enclosure services commands are optional for any SCSI device. The proper place for this device model and the accompanying commands to be defined is SPC or a follow-on document to SPC. The commands used to transmit enclosure service information to or from the device are SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC. A new diagnostic page is defined to contain the transmitted and received information. A page code is provided in RECEIVE DIAGNOSTIC to allow the explicit requesting of the desired enclosure status.

A set of functionality is made available to SCSI devices from the enclosure. One of these functions is the Enclosure Failure Warning, which may be generated by an enclosure to indicate to a SCSI device that a failure condition, including loss of primary power or cooling, has occurred. The action that the drive shall take upon detecting EFW, together with certain other enclosure related states, is set by a new MODE SELECT/MODE SENSE page.

The enclosure services device model defines a very simple device that is capable of being identified and tested as well as performing the transmission of enclosure services information. The processor device model and the communications device model are not appropriate because they mandate commands that cannot be implemented by the enclosure services device model.

2 Modifications to SPC or similar document

2.1 Definition of SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC RESULTS

Section 7.21 of SPC defines the SEND DIAGNOSTIC command. No change is required unless the committee considers it desirable to describe the use of the SEND DIAGNOSTIC command to set enclosure information in this location instead of in section 8.1.2.

Section 7.15 of SPC defines the RECEIVE DIAGNOSTIC RESULTS command. The first paragraph and the parameter descriptions are modified to allow a particular page to be requested and to allow the command to be executed without a preceding SEND DIAGNOSTIC command as follows. Note that this text also corrects a discrepancy in the present definition of the command, where the definition of the returned page is not specified clearly for the case where no SEND DIAGNOSTIC precedes the RECEIVE DIAGNOSTIC RESULTS command.

7.15 RECEIVE DIAGNOSTIC RESULTS command.

The RECEIVE DIAGNOSTIC RESULTS command (see table 40) requests analysis data be sent to the application client after completion of a SEND DIAGNOSTIC command (see 7.21). The command optionally specifies which diagnostic page is to be returned by setting the page code to a page value other than zero.

Table 40: RECEIVE DIAGNOSTIC RESULTS command

| Bits Bytes | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|-------------------------------|---|---|---|---|---|---|---|
| 0 | Operation Code (1Ch) | | | | | | | |
| 1 | reserved | | | | | | | |
| 2 | page code | | | | | | | |
| 3 | (MSB) Allocation Length (LSB) | | | | | | | |
| 4 | | | | | | | | |
| 5 | Control | | | | | | | |

If the target supports the optional page format and a page value of zero is specified by the RECEIVE DIAGNOSTIC RESULTS command, the page code field sent in the previous SEND DIAGNOSTIC command specifies the format of the returned data. If no previous SEND DIAGNOSTIC command was provided from any initiator, the Supported Diagnostic Pages (page code 0) is returned as defined in 8.1.1. If the optional page value is set in the RECEIVE DIAGNOSTIC RESULTS command, the command shall return the specified page. If the optional page value is not implemented by the device server, the target shall return CHECK CONDITION

status with a sense key of ILLEGAL REQUEST and an additional sense code of INVALID FIELD IN CDB.

If the allocation length is greater than the length of the fields to be returned, only the data specified by the page formats is returned. Device servers shall not adjust the content of the returned data to reflect truncation if the allocation length is less than the length specified by the page formats.

[paragraphs including: "A reservation conflict shall occur....page format definitions." remain unchanged.

Section 8.1 Table 63 is modified to define a generic page code for Enclosure Services as shown below.

Table 63 - Diagnostic page codes

| Page Code | Description | Subclause |
|-----------|---|-----------|
| 00h | Supported diagnostics pages | 8.1.1 |
| 01h | Enclosure services page | 8.1.2 |
| 02h-3Fh | Reserved (for all device type pages) | |
| 40h-7Fh | See specific device type for definition | |
| 80h-FFh | Vendor-specific pages | |

An additional paragraph, 8.1.2, is added to define the contents of the Enclosure Services page.

8.1.2 Enclosure services page

An enclosure services out page (see table 65) is defined for the transmission of enclosure management information using a SEND DIAGNOSTIC COMMAND. An enclosure services in page (see table 66) is defined for obtaining enclosure state information using a RECEIVE DIAGNOSTIC RESULTS command. This page is optional.

Table 65” Enclosure services out

| Bits Bytes | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|---|---|---|---|---|---|---|---|
| 0 | Page Code (01h) | | | | | | | |
| 1 | reserved | | | | | | | |
| 2 | (MSB) Page Length (n-3) (LSB) | | | | | | | |
| 3 | | | | | | | | |
| 4 | (MSB) Enclosure management string (vendor unique) (LSB) | | | | | | | |
| n | | | | | | | | |

The enclosure management string is vendor unique. If the enclosure management string contains incorrect information or not enough bytes of information, the action taken by the enclosure management node is not defined by this standard.

Table 65” Enclosure services in

| Bits Bytes | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|---|---|---|---|---|-----|-----|-----|
| 0 | Page Code (01h) | | | | | | | |
| 1 | reserved | | | | | ABS | CHK | EFW |
| 2 | (MSB) Page Length (n-3) (LSB) | | | | | | | |
| 3 | | | | | | | | |
| 4 | (MSB) Enclosure status string (vendor unique) (LSB) | | | | | | | |
| n | | | | | | | | |

The ABS bit indicates that an abnormal state exists within the enclosure that is known to the enclosure management service. Abnormal states indicated by the ABS bit do not require immediate action by host software or by manual intervention. Such abnormal conditions include partial fan failures, partial power supply failures, and other indications for which corrective actions may be deferred.

The CHK bit indicates that a failure has been detected by the enclosure management service that is affecting the operation of the enclosure or its SCSI devices. Failures indicated by the CHK bit indicate that corrective actions must be taken before the enclosure or its supported

devices will operate correctly. Such failures include loss of power, shutdown of power because of power supply failure, and shutdown of SCSI devices because of excessive temperatures in the enclosure.

The EFW bit indicates that the Enclosure Failure Warning signal is being presented to the enclosure management node or to a SCSI device in the enclosure. The EFW bit may be set by an enclosure to warn SCSI devices of an existing or incipient failure. For SCSI devices not meeting the enclosure services model, EFW is the normal mechanism for indicating to the SCSI device that the enclosure has failure information for the SCSI device to transmit to the host.

The ABS, CHK, and EFW bits are individually optional, but at least one of these bits shall be set whenever the RECEIVE DIAGNOSTIC RESULTS enclosure services in page contains information that indicates an abnormal state or failure.

The enclosure status string is vendor unique.

2.2 Definition of enclosure services device model

A new section should be added to SPC or to the appropriate document to describe the enclosure services device model. The model will need a new device type code. The model would be added as section 11. The description of parameters for devices obeying the model would be added as section 12.

11 Model and commands for enclosure services devices

11.1 Model for enclosure services devices

Enclosure services devices define a mechanism to communicate across the SCSI bus with an intelligent node in an enclosure that contains other SCSI devices attached to the same bus. An application client may address the enclosure services logical unit and use the SEND DIAGNOSTIC command and the enclosure services out page code to set various indicators and states in the enclosure, allowing the enclosure to provide the most appropriate environment for the SCSI devices contained within it. Similarly, the application client may request information from the enclosure services logical unit using the RECEIVE DIAGNOSTIC RESULTS command and the enclosure services in page code to examine various status and warning information available from the enclosure. Since each enclosure has a unique configuration, unique capabilities that can be exercised, and unique information that can be examined, the content of the two enclosure services page codes is vendor unique. The application client can make use of the INQUIRY command to determine the characteristics of the enclosure services device.

Some enclosures do not have a node that can be addressed as a logical unit. However, some SCSI devices have a special interface to the enclosure that can be addressed through their normal SCSI connection. Those devices shall use the same SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC RESULTS commands that would be used by an enclosure services device. The mechanism for determining the type of enclosure attached to such a SCSI device is outside the scope of this standard.

11.2 Commands for enclosure services devices

The commands for enclosure services devices shall be as shown in table xx. All remaining operation codes are reserved for future standardization.

Table xx - Commands for enclosure services devices

| Command name | Operation Code | Type | Subclause |
|---|----------------|------|-----------|
| INQUIRY | 12h | M | 7.5 |
| RECEIVE DIAGNOSTIC RESULTS | 1Ch | M | 7.15 |
| RELEASE(6) | 17h | O | 7.16 |
| RELEASE(10) | 57h | O | 7.17 |
| REQUEST SENSE | 03h | M | 7.18 |
| RESERVE(6) | 16h | O | 7.19 |
| RESERVE(10) | 56h | O | 7.20 |
| SEND DIAGNOSTIC | 1Dh | M | 7.21 |
| TEST UNIT READY | 00h | M | 7.22 |
| WRITE BUFFER | 3Bh | O | 7.23 |
| Key: M = Command implementation is mandatory O = Command implementation is optional. | | | |

12 Parameters for enclosure services devices

12.1 Diagnostic Parameters

This subclause defines the descriptors and pages for diagnostic parameters used with enclosure services devices.

The diagnostic page codes for enclosure services devices are defined in table mm.

Table mm: Enclosure Services diagnostic page codes

| Page Code | Description | Subclause |
|-----------|---|-----------|
| 00h | Supported diagnostics pages | 8.1.1 |
| 01h | Enclosure services page | 8.1.2 |
| 02h-3Fh | Reserved (for all device type pages) | |
| 40h-7Fh | See specific device type for definition | |
| 80h-FFh | Vendor-specific pages | |

2.3 Additional ASC/ASCQ for enclosure services function integrated into devices.

Two new ASC/ASCQ values should be defined for devices that provide the enclosure services pages, whether they are enclosure service devices or other device models that provide an interface to the enclosure.

Enclosure Failure: This ASC/ASCQ is provided to indicate when an enclosure failure has been detected by the device monitoring the enclosure status. This is provided using the Sense Key of **HARDWARE ERROR**. Further information may be available using the **REQUEST DIAGNOSTIC RESULTS** command and requesting the enclosure services in page.

Enclosure Degraded Warning: This ASC/ASCQ is provided to indicate that the device monitoring the enclosure status has determined that the enclosure is not operating normally. This is provided using the Sense Key of **RECOVERED ERROR** and may be managed by the Informational Exceptions Control mode page. Further information may be available using the **REQUEST DIAGNOSTIC RESULTS** command and requesting the enclosure services in page.

2.4 Additional MODE SENSE/MODE SELECT pages for enclosure services.

The mode select pages defined for all devices should include the necessary definitions for support of devices that support enclosure services. This will be added as a new section to section 8.3, probably placed alphabetically between sections 8.3.2 and 8.3.3. In addition, Table 80 will need to have an additional entry to include the new optional page. The entry is obvious, and so will not be expanded here. The text of the new section will be as follows:

8.3.n Enclosure services management page.

The enclosure services management page (see table qq) provides controls over those SCSI features involving communication with the enclosure for a SCSI device.

Table qq” Enclosure services management page

| Bits Bytes | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|-------------|-------|------------------|---|---|---|----------|---|
| 0 | PS | Rsrvd | Page Code (TBDh) | | | | | |
| 1 | Page length | | | | | | | |
| 2 | Reserved | | | | | | | |
| 2 | | | | | | | EFW Mode | |
| 2 - 7 | Reserved | | | | | | | |

The EFW (Enclosure Failure Warning) Mode describes the operations that the SCSI device will perform if the enclosure presents an enclosure failure warning to it. The enclosure may transmit such a warning when a new ESI status is available, when a partial or incipient failure is detected, when a complete failure is detected, or any combination of these. The application client uses the EFW Mode bits to adjust the behavior of the SCSI device to properly accommodate whichever type of warnings the enclosure is known to provide.

Table qp - EFW Mode values

| EFW value | | | Description |
|------------|-------|-------|--|
| bit 2 | bit 1 | bit 0 | |
| 0 | 0 | 0 | Default mode, SCSI device vendor unique. |
| 0 | 0 | 1 | Terminate at block boundary and reset |
| 0 | 1 | 0 | Terminate at command boundary and temporarily suspend. |
| 0 | 1 | 1 | Post error according to informational exceptions page |
| All others | | | Vendor-specific pages |

The default EFW Mode allows a vendor unique recovery or error presentation action to be taken by the SCSI device.

If the terminate at block boundary and reset mode is supported by the SCSI device and is requested by the MODE SENSE/SELECT procedure, the SCSI device shall execute the following actions upon detecting an EFW indication.

- The SCSI device server shall terminate any active media modification (write) tasks at an appropriate block boundary ending point.
- All other tasks on the SCSI device shall end and the device shall return all parameters to their power on initial reset state.
- The device server shall respond to any new commands with CHECK CONDITION status and indicate the presence of an EFW indication as long as the EFW condition is still present.
- The SCSI transport mechanism remains active and initialized.
- After the EFW state is ended, the first command received shall indicate CHECK CONDITION status and UNIT ATTENTION sense information. Subsequent tasks will be executed normally.

If the terminate at command boundary and temporarily suspend mode is supported by the SCSI device and is requested by the MODE SENSE/SELECT procedure, the SCSI device shall execute the following actions upon detecting an EFW indication.

- The SCSI device server shall terminate any active media modification (write) tasks at an appropriate block boundary ending point and provide a CHECK CONDITION indication with sense information indicating an ASC/ASCQ of Enclosure Failure.
- All further tasks on the drive shall be temporarily suspended.

- The device server shall respond to any command that does not access the drive media without regard to the EFW state.
- The drive shall respond to any command that accesses the drive media with CHECK CONDITION status and with sense information indicating an ASC/ASCQ of Enclosure Failure.
- Outstanding tasks shall remain suspended until after the EFW indication is ended.
- Normal drive operation shall resume after the EFW signal is ended. Suspended operations are resumed.

If the post error according to informational exceptions page mode is supported by the SCSI device and is requested by the MODE SENSE/SELECT procedure, the SCSI device shall execute the following actions upon detecting an EFW indication.

- The SCSI device server shall not abnormally terminate any activity. All commands shall continue normal operation.
- The EFW check condition shall be posted under the rules of the notification procedure defined for background errors in the informational exceptions mode page. These rules typically require the posting of a CHECK CONDITION for a command the first time the EFW is detected, then periodically reposting the CHECK CONDITION as required by the setting of the MODE SELECT page as long as the EFW condition is present.
- Normal device operation continues after the EFW condition is terminated and no additional posting activity takes place.