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Subject: SCSI-3 Pathing Commands

Reference: Documents 90-132R04, 91-199R00, 91-199R1

This document contained definitions of those commands required to support the multi-pathing support of GPP. These commands are needed to establish and maintain the environment for multi-pathing.

All of the commands are optional in the GPP environment. They might be useful in SIP if the logical model were enhanced.

These command descriptions were first presented in 90-132 R04. They are repackaged here to represent the document structure for SCSI-3. These commands would be places in the SCSI-3 common command set standard.

One attribute of each physical protocol is whether multiple pathing is supported. Each XXP document contains a statement about this support and that determines whether a device driver should attempt them. This could be a CAM-2 enhancement to report the interface type.

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Section 1. Commands Common to All Device Classes

This section describes all commands which are common to all device classes. Several of the commands are mandatory for logical units. The remainder are optional unless they are designated as mandatory in the appropriate device class section.

1.1 Characteristics of All Device Classes

This section describes some of the general characteristics expected of SPP devices. Prior sections of this standard also contain information pertaining to all device classes.

1.1.1 Commands Implemented by All Logical Units (Mandatory)

This standard defines four commands that all logical units shall implement: INQUIRY, REQUEST SENSE, SEND DIAGNOSTIC, and TEST UNIT READY. These commands are used to determine the logical system, important to test logical units, and to return important information concerning errors and exception conditions.

1.1.1.1 Using the INQUIRY Command

The INQUIRY command may be used by a system to determine the logical system configuration. Logical Units respond with information that includes their type and standard level and may include vendor identification, model number and other useful information. It is recommended that target controllers be capable of returning this information (or whatever part of it that is available) upon completing power-on initialization. A logical unit may take longer to get certain portions of this information, especially if it retrieves the information from the medium.

1.1.1.2 Using the REQUEST SENSE Command

Whenever a contingent allegiance or extended contingent allegiance condition is established for a logical unit, the initiating controller that received the error should issue a REQUEST SENSE command to receive the sense data describing what caused the condition unless the sense data is provided as autosense data with the status. If the initiating controller issues some other command and autosense data has not been provided, the sense data is lost.

1.1.1.3 Using the SEND DIAGNOSTIC Command

The SEND DIAGNOSTIC command provides a means to request the logical unit to perform a self test. Only the self test feature of the SEND DIAGNOSTIC command is mandatory. All other command features are optional. While the self test is logical unit specific, the means of requesting the test is standardized and the response is simply GOOD status if all is well or CHECK CONDITION status if the test fails.

1.1.1.4 Using the TEST UNIT READY Command

The TEST UNIT READY command is useful in that it allows an initiating controller to poll a logical unit until it is ready without the need to allocate space for returned data. It is especially useful to check status of logical units with removable media. Logical units are expected to respond promptly to indicate the current status (i.e., a logical unit should avoid lengthy disconnections in an attempt to respond with GOOD status).

1.1.2 Commands for All Device Classes

The operation codes for commands that apply to all logical units for all device classes are listed in Table 1-1 on page 1-2. Commands identified as mandatory shall be implemented for logical units.

When a command is implemented, whether mandatory or optional, all functions identified as mandatory within the command shall be implemented.

Table 1-1. Commands for All Device Classes			
Command Name	Operation Code	Logical Unit Support	Section
ASSIGN	xxh	O	1.2.1
CONTROL ACCESS	xxh	O	1.2.2
REPORT PATH STATUS	xxh	O	1.2.3
SET ICID	xxh	O	1.2.4
UNASSIGN	xxh	O	1.2.5
Key: M = Command implementation is mandatory. O = Command implementation is optional. R = Reserved Z = Command implementation is device class specific. See the appropriate device class section			

1.2 Command Descriptions

The commands listed in Table 1-1 are defined in this section. Each command description starts on a right-hand page.

1.2.1 ASSIGN Command

(move to correct position. GRS)

Table 1-2. ASSIGN Command								
Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (XXh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 - 8	(MSB)	Command Parameter Data Length						(LSB)
9	Control Field							
Command Attributes:								
<ul style="list-style-type: none">• Bypass Assignment: NO• Bypass Reservation: NO• Singular Command: NO• Supervisor Command: YES• Command Parameter Data: YES• Command Response Data: NONE• Logical Unit Status: Valid LUN, Other status N/A								

The purpose of the ASSIGN command (Table 1-2) is to act as the logical equivalent of switches or manual cable changes to restrict access to logical units. Physical reconfigurations may be impractical or impossible in a logical system to effect the desired access restrictions. Both initiating controllers and target controllers must keep track of assignment. Both must communicate on the appropriate paths and the target controller must be prepared to reject attempts for access from unassigned paths. If explicitly named path groups are supported, this command and all CDB options shall be supported.

The ASSIGN command specifies the path group on which a logical unit may operate. Any logical unit is initially available to receive I/O processes from any initiating controller attached to the target controller. This use privilege is extended whether the path is explicitly named, implicitly named, and whether for explicitly named paths, the path is grouped or ungrouped. Two or more established path groups may share use privileges to the exclusion of other paths or path groups. An implicitly named path may hold assignment for itself.

Assignment to one path group or to one implicitly named path means that no initiating controller on any path not in the assigned path group or the single assigned implicitly named path shall gain access to the logical unit unless temporary assignment has been granted through the CONTROL ACCESS command. Any path holding assignment through an established path group may add assignment of other established path groups. The mechanism by which an initiating controller obtains the path group name required for adding assignment of other path groups is not defined in SPP.

A logical unit may be assigned to multiple established path groups. An implicitly named path or an ungrouped path can gain assignment for itself, but it shall not be capable of adding assignment for any other paths or path groups.

The two functions of assignment are:

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1) If the command parameter data length value is zero, assign this LUN or TRN to the path group on which the command was received. It shall not be an error to receive this command on a path which currently has assignment.

2) If the command parameter data length is 16 and the ICID name field matches the name of another established path group, and the path on which the command is received also has assignment, the target controller shall add assignment of the LUN or TRN to the other established path group. It shall not be an error to receive this command on a path which currently has assignment and which requests assignment for another established path group for which assignment currently exists. If the ASSIGN command is received on a path for which assignment does not exist and requests assignment for another established path group, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to If the ICID Name field does not match the ICID name of another established path group in the target controller, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

The command parameter data is defined in Table 1-3.

Table 1-3. Command Parameter Data for ASSIGN Command								
Bit Byte	7	6	5	4	3	2	1	0
0 - 11	ICID Name (MSB) (LSB)							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

The ICID Name field of the ASSIGN command consists of a 12 byte left justified ASCII value which uniquely names the path group for which assignment is to be made. See the SET ICID command for the construction of the ICID Name field. If the ICID Name field is set to all 20h (i.e., all blanks), the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

1.2.2 CONTROL ACCESS Command

(move to correct position. GRS)

Table 1-4. CONTROL ACCESS Command								
Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (XXh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 - 8	(MSB)	Command Parameter Data Length						(LSB)
9	Control Field							
Command Attributes:								
<ul style="list-style-type: none">• Bypass Assignment: YES with Correct Password• Bypass Reservation: NO• Singular Command: NO• Supervisor Command: YES• Command Parameter Data: YES• Command Response Data: NONE• Logical Unit Status: Valid LUN, Other status N/A								

The CONTROL ACCESS command (Table 1-4) transfers a password on an assigned path to the target controller for a path group; or, permits general unassign from an assigned path group; or, allows an unassigned path having the correct password access to a logical unit for one I/O process. Breaking assignment may be temporary or permanent, but it shall be controlled. If explicitly named path groups are supported, this command and all CDB options shall be supported.

Controlled access permits access outside the bounds of assigned path groups. The CONTROL ACCESS command provides a mechanism to prevent deliberate or accidental loss of assignment protection is the control access function, enabled by a password, and checked by the affected target controller.

A password is established by an initiating controller having assignment. The password is not reported by a target controller on any path. The target controller checks its established password, if any, against password supplied by the control access command function from an initiating controller not having assignment.

If the target controller has an established password and it matches the password with the command, the control access command and any commands linked to it are executed, if possible. The mechanism by which the unassigned initiating controller acquires the correct password is not defined in SPP.

The command parameter data length value shall be 16.

Table 1-5. Command Parameter Data for CONTROL ACCESS Command								
Bit Byte	7	6	5	4	3	2	1	0
0 - 11	(MSB) ICID Name (LSB)							
12	EstabPwd	GnlUnasn	ReqTAsgn	Reserved				
13	Reserved							
14	Reserved							
15	Reserved							

The ICID Name field of the UNASSIGN command consists of a 12 byte left justified ASCII value which uniquely names the path group for which assignment is to be made. See the SET ICID command for the construction of the ICID Name field. If the ICID Name field is set to all 20h (i.e., all blanks), the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

The control access command has three functions:

1) if the establish password (EstabPwd) bit is set to one, establish a password in a target controller. The command must be received on a path currently holding assignment. Only one password, the first received, shall be the password for the established path group. If a password exists and the password in the command parameter data is not equal to the established password, terminate the I/O process with contingent allegiance. The sense key shall be and the additional sense shall be

2) if the general unassign (GnlUnasn) bit is set to one, and the the CONTROL ACCESS command is received on a path that does not have assignment, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to Otherwise, if no password has been set or the password supplied matches the password in the target, the target controller removes assignment for all paths in any path group having assignment when the command was processed.

3) if the request temporary assignment (ReqTAsgn) bit is set to one, and the control access command is received from a path that does not have assignment and the password matches the password in the target controller, the CONTROL ACCESS command and any commands linked to it are executed to the extent possible. A status which would lead to contingent allegiance or extended contingent allegiance on the unassigned path is not permitted, since that would grant the unassigned path permission to start a second I/O process (first to retrieve the sense data and then link additional commands based on the results of the sense data analysis. The contingent allegiance or extended contingent allegiance is made with an assigned path whether functional or not. Asynchronous event notification may be used to report the condition on the alternate path.

NOTES:

1) When a request for temporary assignment is granted, the issuing initiating controller may link to an assign command which will grant assignment to the once unassigned initiating controller. The initiating controller can then use normal I/O processes.

2) An I/O process containing a valid control access command requesting temporary assignment, a control access command performing a general unassign, and an assign command for the new initiating controller breaks all old assignments and transfers assignment of the LUN to the new initiating controller. This operation permits continued operation without loss of the function provided by the logical unit. Some I/O processes may be aborted.

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1.2.3 REPORT PATH STATUS Command

(move to correct position. GRS)

Table 1-6. REPORT PATH STATUS Command								
Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (XXh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Field							
Command Attributes: <ul style="list-style-type: none">• Bypass Assignment: NO• Bypass Reservation: NO• Singular Command: YES• Supervisor Command: NO• Command Parameter Data: NONE• Command Response Data: YES• Logical Unit Status: Valid LUN, Other status N/A								

The REPORT PATH STATUS command (Table 1-6) reports the status of the path on which the connect was made relative to the path group naming level and status of a path group. The command response data provides the target controller status of the path and path group. There are no options specified in the CDB. If explicitly named path groups are supported, this command and all CDB options shall be supported. The command response data is defined in Table 1-7.

Table 1-7. Command Response Data for REPORT PATH STATUS Command								
Bit Byte	7	6	5	4	3	2	1	0
0 - 11	(MSB) <div>ICID Name</div> (LSB)							
12	ValICID	ImplPath	PathOthr	Ungrp'd	Grouped	Reserved		
13	Reserved							
14	Reserved							
15	Reserved							

If the Valid ICID (ValICID) bit is set to one then the ICID name field contains a valid ICID name from the target controller. A value of zero for the ValICID bit means that the ICID Name field shall be ignored. When the PathOthr, Ungrp'd, or Grouped is set to one, the ValICID bit shall be set to one. In this instance, if the target controller returns command response data with the ValICID bit is set to zero, If the ImplPath bit is set to one and the ValICID bit is set to one in the command response data,.... When the ValICID bit is set to one, the ICID Name field contains the ICID value transferred by a SET ICID command which was successfully executed.

The state of the path may be any one of the following:

- 1) If the Implicitly named path (ImplPath) bit is set to one, no explicit ICID has been received from the initiating controller to any LUN or TRN on this target controller using this path. An I/O process received on a path in this state shall operate in single path mode.
- 2) If the Path to Other LUNs (PathOthr) bit is set to one, an explicitly named path to at least one LUN or TRN on this path, other than the one selected exists. This is functionally equivalent to status 1), but it imparts additional information to the initiating controller. An I/O process received on a path in this state shall operate in single path mode.
- 3) If the Ungrouped (Ungrp) bit is set to one, an explicitly named path to the selected LUN or TRN exists for this path, but it is not currently part of an established path group. An I/O process received on a path in this state operates in single path mode.
- 4) If the Grouped bit is set to one, an explicitly named path to the selected LUN or TRN exists and is currently established in the grouped state. The path group can consist of one or more paths. An I/O process received on this path may respond on any path in this path group unless single path status is in effect or multiple path operation has been temporarily suspended for an I/O process.

The ImplPath, PathOthr, Ungrp, and Grouped bits are mutually exclusive. If the target controller returns command response data with more than one of these bits set to one,

1.2.4 SET ICID Command

(move to correct position. GRS)

Table 1-8. SET ICID Command								
Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (XXh)							
1	Reserved							
2	Reserved		NamePath	AddPath	RmvPath	EstabPG	SnglStus	DsbndPth
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 - 8	(MSB) <div>Command Parameter Data Length</div> (LSB)							
9	Control Field							
Command Attributes: <ul style="list-style-type: none">• Bypass Assignment: NO• Bypass Reservation: NO• Singular Command: YES• Supervisor Command: NO• Command Parameter Data: YES• Command Response Data: NONE• Logical Unit Status: Valid LUN, Other status N/A								

The SET ICID command (Table 1-8) has five functions: to explicitly name the initiating controller using this path on which a connect occurred; to add a path to an established path group; to remove a path from an established path group; to establish a path group; to disband a path group. This command is valid only for logical units. If explicitly named path groups are supported, this command and all CDB options shall be supported.

A path shall be explicitly named before it can be included in an established path group. The set of paths consisting of the same ICID and LUN in a target controller is called a path group. Naming the paths in a path group does not establish the path group. If an established path group is required, it shall be explicitly established using this command with the correct option specified. Establishing a path group is the mechanism for enabling multiple path operations in logical system and allowing assignment for multiple paths. Including a path in a path group does not restrict access to the logical unit from any other path.

When the name path (NamePath) bit is set to one, the command is used to name the path on which the connect is made. Command parameter data supplies the ICID of the initiating controller. The interface control prefix fields contain the remaining information to completely name the path to a LUN. The LUN must be valid for the target controller. The path remains in an ungrouped state. Explicitly naming a path to a logical unit does not alter access privileges (i.e., assignment). If the NamePath bit is set to one, and the RmvPath, the EstabPth, or DsbndPth bit is set to one, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to The SnglPath bit shall be ignored. The command parameter data length shall be set to 16. See the command parameter description below.

When the name path (NamePath) bit is set to one and the path already has been given a name, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

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When the name path (NamePath) bit is set to zero, the path name function shall not be invoked in the target controller.

A path may be added to an established group at a later time by a command from the initiating controller on the path to be added to the path group. When the add path (AddPath) bit is set to one, the named path which has been previously named or is named with this command, if the NamePath bit is set to one, shall be added to an established path group of the same name. The attributes of the path group shall be transferred to the new path. The path enters the grouped state. Adding a path to a path group causes the assignment status of the path group to be transferred to the new path. Adding a path to If the AddPath bit is set to one and the RmvePath bit, the EstabPth bit, or the DsbndPth bit is set to one, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to The SnglPath bit shall be ignored. The command parameter data length shall be set to 16. If the ICID name does not match an established path group, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to If the path does not have a name assigned and the AddPath bit is set to one, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

A path may be removed from an established path group by a command from the initiating controller on the path to be removed from the path group. When the remove path (RmvePath) bit is set to one, the named path which has been previously named, shall be deleted from the established path group of the same name. The attributes of the path group shall be removed from the path. The path enters the ungrouped state. The path retains the name provided through the add path function. Removing a path from a path group removes assignment for that path if assignment exists for the path group. A path group is implicitly disbanded when the last path is removed from an established path group using the RmvePath function rather than a disband command. The logical path remains as it did before the path group was established. If the RmvePath bit is set to one and the AddPath bit, the EstabPth bit, or the DsbndPth bit is set to one, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to The SnglPath bit shall be ignored. The command parameter data length shall be set to 16. If the ICID name does not match an established path group, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to If the path does not have a name assigned and the RmvePath bit is set to one, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

A set of named paths shall be established as a path group when the establish path (EstabPth) bit is set to one. The value of the single path status (SnglStus) bit is used in conjunction with the EstabPth bit as specified below. The status reporting attribute can only be changed by disbanding the path group and reestablishing it with the desired attribute. Each path in the newly established path group enters the grouped state. Establishing a path group for a logical unit does not alter access privileges. If the EstabPth bit is set to one and the AddPath bit, the RmvePath bit, or the DsbndPth bit is set to one, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to The command parameter data length shall be set to 16. If the ICID name does not match the name of one or more paths in an ungrouped state, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

If the EstabPth bit is set to one and the single path status (SnglStus) bit is set to one, the path group is established with the attribute that any contingent allegiance or extended contingent allegiance condition shall be reported on the path where the connect was made for each I/O process initiated in the path group. This is called single path status mode. Any report status may be returned on any valid path in the established path group.

If the EstabPth bit is set to one and the single path status (SnglStus) bit is set to zero, the path group is established with the attribute that any contingent allegiance or extended contingent allegiance condition may be reported on any path in the established path group. This is called multiple path status mode. Any report status may be returned on any valid path in the established path group.

The inverse of establishing a path group is to disband a path group. A path group shall be explicitly disbanded when the disband path group (DsbndPth) bit is set to one and the command is received from the initiating controller along any one path in the path group. Each path enters the ungrouped state. Each path retains the name provided through the add path function. Disbanding a path group removes assignment for that path if assignment exists for the path group. If the DsbndPth bit is set to one and the AddPath bit, the RmvePath bit, or the EstabPth bit is set to one, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to The SnglPath bit shall be ignored. The command parameter data length shall be set to 16. If the ICID name does not match the name of an established path group, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

Table 1-9. Command Parameter Data for SET ICID Command								
Bit Byte	7	6	5	4	3	2	1	0
0 - 11	(MSB) ICID Name (LSB)							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

The ICID Name field of the SET ICID command consists of a 12 byte left justified ASCII value which uniquely names the initiating controller responsible for the initiator making the connect for the SET ICID command. The ICID Name is not an attribute of the initiator used to send the SET ICID command; it is an attribute of the controller of the initiator. An ICID Name shorter than 12 bytes shall be padded to the LSB with ASCII blanks (20h). If the ICID Name field is set to all 20h (i.e., all blanks), the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

NOTE: The ICID Name value can be a manufacturer ID concatenated with the serial number of the computer system. That is, all initiators in the same computer system use the same initiating controller ID so that path grouping of several paths is possible. This also permits multiple path operations.

1.2.5 UNASSIGN Command

(move to correct position. GRS)

Table 1-10. UNASSIGN Command								
Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (XXh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 - 8	(MSB)	Command Parameter Data Length						(LSB)
9	Control Field							
Command Attributes: <ul style="list-style-type: none">▪ Bypass Assignment: NO▪ Bypass Reservation: NO▪ Singular Command: NO▪ Supervisor Command: YES▪ Command Parameter Data: YES▪ Command Response Data: NONE▪ Logical Unit Status: Valid LUN, Other status N/A								

The UNASSIGN command (Table 1-10) is used to remove a path group from the set of assigned path groups. If explicitly named path groups are supported, this command and all CDB options shall be supported.

Use privileges may be unassigned for any path group to which assignment currently exists from any path for which assignment currently exists. The mechanism by which an initiating controller obtains the path group name required for removing assignment of other path groups is not defined in SPP. If the ASSIGN command is received on a path for which assignment does not exist, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

The two functions of unassignment are:

- 1) If the command parameter data length value is zero, unassign this LUN or TRN to for the established path group on which the command was received.
- 2) If the command parameter data length is 16 and the ICID name field matches the name of another established path group which has assignment, the target controller shall remove assignment of the LUN or TRN for the other established path group. If the ICID Name field does not match the ICID name of another established path group in the target controller, the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to

The command parameter data is defined in Table 1-11 on page 1-14.

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Table 1-11. Command Parameter Data for UNASSIGN Command								
Bit Byte	7	6	5	4	3	2	1	0
0 - 11	(MSB) ICID Name (LSB)							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

The ICID Name field of the UNASSIGN command consists of a 12 byte left justified ASCII value which uniquely names the path group for which assignment is to be made. See the SET ICID command for the construction of the ICID Name field. If the ICID Name field is set to all 20h (i.e., all blanks), the command shall be rejected with a contingent allegiance with the sense key set to and the additional sense set to