To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 19 December 2006
Subject: 06-188r3 SAS-2 Support multiple STP affiliations

Revision history

Revision 0 (26 April 2006) First revision
Revision 1 (4 September 2006) Incorporated comments from May 2006 SAS protocol WG.
Revision 2 (24 October 2006) Incorporated comments from September 2006 SAS protocol WG. Incorporated comments from Kevin Marks (Dell) to change the NOTE about STP/SATA bridge duties regarding multiple affiliations into normative text.
Revision 3 (19 December 2006) Incorporated comments from November 2006 SAS protocol WG.

Related documents

sas2r03 - Serial Attached SCSI - 2 (SAS-2) revision 3

Overview

STP target ports (particularly those in STP/SATA bridges) can currently report support for two different modes in the SMP REPORT PHY SATA response:

a) Affiliations supported (i.e., one affiliation). The STP target port allows only one STP initiator port to access it at a time; connections from others are rejected with OPEN_REJECT (STP RESOURCES BUSY).
b) Affiliations not supported (i.e., infinite affiliations). The STP target port must have the ability to track all SATA commands by the STP initiator ports' SAS addresses, and allows simultaneous access to the ATA task file registers. This model assumes the STP target port supports essentially infinite STP initiator ports. SATA NCQ supports only 32 commands at a time which provides some relief. OPEN_REJECT (STP RESOURCES BUSY) can be used.

It is possible to create a hybrid STP/SATA bridge that supports a limited number of STP initiator ports, greater than zero but less than infinity (e.g., two or four). This can be viewed as supporting multiple simultaneous affiliations.

Changes are proposed to expand the REPORT PHY SATA function to report more than one active affiliation, and to modify the rest of the text in the standard to support the concept of multiple affiliations.

The STP I_T NEXUS LOSS OCCURRED bit and STP I_T NEXUS LOSS SAS ADDRESS field are clarified as being per-affiliation context; an AFFILIATION CONTEXT field is added to PHY CONTROL for use by the CLEAR STP I_T NEXUS LOSS phy operation.

Affiliations are defined as cleared because of STP I_T nexus loss, but not because of all link reset sequences not caused by the PHY CONTROL function LINK RESET phy operation.

Suggested changes

3.1.xx affiliation context: A set of ATA task file registers maintained by an STP target port for an STP initiator port holding an affiliation. See 7.17.5.

4.4 Resets

4.4.1 Reset overview

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The link reset sequence has no effect on the transport layer and application layer. The HARD_RESET primitive sequence may be used during the identification sequence to initiate a hard reset. The link reset sequence serves as a hard reset for SATA devices (see ATA/ATAPI-7 V3).

4.5 I_T nexus loss

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If the I_T nexus loss timer expires in an STP target port, then the port shall abort any commands for the lost STP initiator port. If the STP target port is in an STP/SATA bridge, the STP/SATA bridge shall originate a link reset sequence to the SATA device.

If the I_T nexus loss timer expires in an STP initiator port, then the port shall consider any commands for the lost STP target port to be completed with an error. This serves as a nexus loss event (see ATA8-AAM).

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7.2.7.4 SATA_R_RDY and SATA_X_RDY (Receiver ready and transmitter ready)

When a SATA port has a frame to transmit, it transmits SATA_X_RDY and waits for SATA_R_RDY before transmitting the frame. ~~Expander devices shall not transmit SATA_R_RDY or SATA_X_RDY on the SATA physical link until the STP connection is established.~~

Editor's Note 1: That is definitely not true for the initial register FIS, and is not necessarily true thereafter. In many cases, multiple affiliation bridges must send SATA_R_RDY and accept at least the frame header to determine the proper recipient of the frame. Even a single affiliation bridge could accept a full frame on its own to keep its STP target port from introducing HOLD/HOLDA flow control on the SAS side, providing better link utilization.

7.2.7.5 Other primitives used inside STP connections and on SATA physical links

Other primitives used in STP connections and on SATA physical links are defined in SATA.

7.2.5.11 OPEN_REJECT

All of the OPEN_REJECT versions defined in table 88 shall result in the originating port abandoning the connection request.

Table 88 — OPEN_REJECT abandon primitives

Primitive	Originator	Description
...	...	...
OPEN_REJECT (STP RESOURCES BUSY)	Destination phy	STP target port with destination SAS address exists but the STP target port supports affiliations and is not able to establish ~~has~~ an affiliation with ~~another~~this STP initiator port (e.g., because it has reached its maximum number of affiliations) or the STP target port does not support affiliations and all of the available ATA task file registers have been allocated to other STP initiator ports (see 7.17.5). Process the same as OPEN_REJECT (WRONG DESTINATION) for non-STP connection requests.

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7.14.4.4 SL_CC2:Selected state

7.14.4.4.1 State overview

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4) If the OPEN address frame PROTOCOL field is set to STP, the STP target port supports affiliations and the source SAS address is not that of ~~the~~an STP initiator port with an affiliation established or the STP target port does not support affiliations and the source SAS address is not that of an STP initiator port with ATA task file register set resources (see 7.17.5), this state shall send a Transmit OPEN_REJECT (STP Resources Busy) message to the SL transmitter (see 7.14.4.4.2);

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7.17.5 Affiliations

The STP target port shall provide coherent access to an ATA task file register set for each STP initiator port from which it accepts connections. It may use affiliations to limit the number of STP initiator ports that establish connections and for which it maintains an ATA task file register set. An affiliation is a state entered by an STP target port where it refuses to accept connection requests from STP initiator ports other than ~~the~~ one that has established an affiliation.

STP target ports implement one of the affiliation policies defined in table 88.

Table 88 — Affiliation policies

Affiliation policy	Description
No affiliations	An unlimited number of STP initiator ports are allowed to access the STP target port concurrently. The STP target port is cognizant of the SAS address of the STP initiator port that sends each ATA command.
Multiple affiliations	The STP target port implements more than one affiliation, so a limited number of STP initiator ports are allowed to access the STP target port concurrently. The STP target port implements no more than one affiliation context per STP initiator port.
Single affiliation	The STP target port implements one affiliation, so one STP initiator port is allowed to access the STP target port at a time.

~~Coherent access to the SATA task file registers shall be provided for each STP initiator port. STP target ports that do not track all commands by the STP initiator ports' SAS addresses shall implement affiliations to provide coherency. STP target ports that track all commands by the STP initiator ports' SAS addresses shall not implement affiliations.~~

An STP/SATA bridge that supports multiple affiliations shall:

a) ensure that the SATA NCQ tags in commands issued to the SATA device are unique across all affiliations;
b) ensure that a non-queued command received in one affiliation context is not issued to the SATA device while another affiliation context has a queued command outstanding to the drive (e.g., the STP target port shall allow all queued commands in the SATA device to complete prior to issuing the non-queued command); and
c) ensure that a queued command received in one affiliation context is not issued to the SATA device while another affiliation context has a non-queued command outstanding to the drive (e.g., the STP target port shall allow any non-queued command in the SATA device to complete prior to issuing the queued commands).

An STP/SATA bridge that supports multiple affiliations may modify the queue depth reported in the ATA IDENTIFY DEVICE data (see ATA8-ACS) to each STP initiator port to ensure that all the STP initiator ports with affiliations do not send more commands than the SATA device supports.

An STP target port that supports affiliations shall establish an affiliation whenever it accepts a connection request from an STP initiator port that does not already have an affiliation. When ~~an~~the maximum number of affiliations have been ~~is~~ established (i.e., all affiliation contexts are in use), the STP target port shall reject all subsequent connection requests from other STP initiator ports with OPEN_REJECT (STP RESOURCES BUSY).

An STP target port shall maintain an affiliation until any of the following occurs:

a) power on;
b) the ~~SAS target device~~management device server receives an SMP PHY CONTROL request specifying the phy with the affiliation and specifying a phy operation of HARD RESET (see 10.4.3.14) from any SMP initiator port;
c) the ~~SAS target device~~management device server receives an SMP PHY CONTROL request specifying the phy with the affiliation and specifying a phy operation of TRANSMIT SATA PORT SELECTION SIGNAL (see 10.4.3.14) from any SMP initiator port;

d) the ~~SAS target device~~management device server receives an SMP PHY CONTROL request specifying the phy with the affiliation and specifying a phy operation of CLEAR AFFILIATION (see 10.4.3.14) from the same SAS initiator port that has the affiliation.

If a connection is already established to the STP target port on one phy while an SMP PHY CONTROL request specifying a phy operation of CLEAR AFFILIATION is processed by an SMP target port on another phy, the affiliation shall be cleared and the STP target port shall respond to new connection attempts with:

A) AIP (WAITING ON CONNECTION) and/or OPEN_REJECT (RETRY), if the STP target port is in an expander device; or
B) OPEN_REJECT (RETRY), if the STP target port is in a SAS device;

rather than OPEN_REJECT (STP RESOURCES BUSY);

e) an STP connection ~~to the phy with the affiliation~~to a phy in the STP target port is closed with CLOSE (CLEAR AFFILIATION); or

f) the STP target port encounters an I_T nexus loss.

~~g) the STP target port is part of a STP/SATA bridge and a link reset sequence is begun on the SATA physical link that was not requested by an SMP PHY CONTROL request specifying the phy and specifying a phy operation of LINK RESET (see 10.4.3.14).~~

Editor's Note 2: Before this change, STP I_T nexus loss clears affiliations in STP/SATA bridges because it causes a link reset sequence, but does not clear them in native STP target ports. Those two should be consistent. Brad Besmer (LSI) suggested we get rid of link reset as a clearing reason - there is no benefit from clearing the affiliation on the SAS STP side because of a change on the SATA host side. Clearing just opens a window where another STP initiator can sneak in and confuse the one that had it before, which still thinks it has the affiliation, at least until it parses BROADCAST (CHANGE) and notices the phy changed. If another initiator chooses to take over the affiliation, it should use HARD RESET to do so directly.

The STP initiator port shall maintain an affiliation starting with the connection in which ~~An affiliation established when~~ a command is transmitted ~~shall be maintained~~ until all frames for the command have been delivered. An STP initiator port implementing command queuing (see SATAII-EXT) shall maintain an affiliation while any commands are outstanding ~~to avoid confusing SATA devices, which only understand one SATA host~~. STP initiator ports may keep affiliations for longer tenures, but this is discouraged.

An STP target port that implements affiliations shall implement at least one affiliation context per STP target port. Multiple phys on the same STP target port shall use the same set of affiliation contexts. Support for affiliations is indicated in the SMP REPORT PHY SATA response (see 10.4.3.7).

An STP target port implementing multiple affiliations shall sort the affiliation contexts in a vendor-specific order. In the SMP REPORT PHY SATA response, if the SMP initiator port has the same SAS address as an affiliated STP initiator port, the management device server shall report the affiliation for that SAS address as relative identifier 0 and shall report all additional affiliations with incrementing relative identifiers following the sorted order. If the SMP initiator port does not have the same SAS address as an affiliated STP initiator port, the management device server shall report the affiliation contexts in the vendor-specific order.

For example, if the STP target port supports four affiliation contexts sorted in order A, B, C, and D, when returning the SMP REPORT PHY SATA response to an SMP initiator port, the management device server shall report the affiliation contexts as described in table 89.

Table 89 — Affiliation context relative identifier example

Affiliation context containing the SAS address of the SMP initiator port	Affiliation context relative identifier assignment			
	0	1	2	3
A	A	B	C	D
B	B	C	D	A
C	C	D	A	B
D	D	A	B	C
None	A	B	C	D

7.17.6 Opening an STP connection

~~If no STP connection exists w~~When the SATA host port in an STP/SATA bridge receives a SATA_X_RDY from the attached SATA device, the STP target port in the STP/SATA bridge shall establish an STP connection to the appropriate STP initiator port ~~before it transmits a SATA_R_RDY to the SATA device~~.

Wide STP initiator ports shall not request more than one connection at a time to an STP target port. Wide STP target ports shall not request more than one connection at a time to an STP initiator port.

While a wide STP target port is waiting for a response to a connection request or has established a connection to an STP initiator port, it shall:

a) reject incoming connection requests from that STP initiator port with OPEN_REJECT (RETRY); and
b) if affiliations are supported and the maximum number of affiliations have been established (i.e., all affiliation contexts are in use), reject incoming connection requests from other STP initiator ports that do not have affiliations with OPEN_REJECT (STP RESOURCES BUSY).

Editor's Note 3: no need to list all the "accept" cases - those reject cases are complete

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While a wide STP initiator port is waiting for a response to a connection request to an STP target port, it shall not reject an incoming connection request from that STP target port because of its outgoing connection request. It may reject incoming connection requests for other reasons (see 7.2.5.11).

If a wide STP initiator port receives an incoming connection request from an STP target port while it has a connection established with that STP target port, it shall reject the request with OPEN_REJECT (RETRY).

The first dword that an STP phy sends inside an STP connection after OPEN_ACCEPT that is not an ALIGN or NOTIFY shall be an STP primitive (e.g., SATA_SYNC).

7.17.7 Closing an STP connection

Either STP port (i.e., either the STP initiator port or the STP target port) may originate closing an STP connection. An STP port shall not originate closing an STP connection after sending a SATA_X_RDY or SATA_R_RDY until after both sending and receiving SATA_SYNC. An STP port shall transmit CLOSE after receiving a CLOSE if it has not already transmitted CLOSE.

If an STP port receives a CLOSE after transmitting a SATA_X_RDY but before receiving a SATA_R_RDY, the STP port shall complete closing the connection (i.e., transmit CLOSE) and retransmit the SATA_X_RDY in a new connection.

When an STP initiator port closes an STP connection, it shall transmit a CLOSE (NORMAL) or CLOSE (CLEAR AFFILIATION). When an STP target port closes an STP connection, it shall transmit a CLOSE (NORMAL).

An STP initiator port may issue CLOSE (CLEAR AFFILIATION) in place of a CLOSE (NORMAL) to cause the STP target port to clear the affiliation (see 7.17.5) along with closing the connection. If an STP target port receives CLOSE (CLEAR AFFILIATION), the STP target port shall clear the affiliation for the STP initiator port that sent the CLOSE (CLEAR AFFILIATION).

See 7.12.7 for additional details on closing connections.

An STP/SATA bridge shall break an STP connection if its SATA host phy loses dword synchronization (see 7.12.8).

7.17.9 STP (link layer for STP phys) state machines

The STP link layer uses the SATA link layer state machines (see ATA/ATAPI-7 V3), modified to:

a) communicate with the port layer rather than directly with the transport layer;
b) interface with the SL state machines for connection management (e.g., to select when to open and close STP connections, and to tolerate idle dwords between an OPEN address frame and the first SATA primitive); and
c) ~~implement affiliations~~ support an affiliation policy (see 7.17.5).

These modifications are not described in this standard.

9.3 STP transport layer

9.3.1 Initial FIS

A SATA device phy transmits a Register - Device to Host FIS after completing the link reset sequence (see G.5 for exceptions to this). The expander device shall update a set of shadow registers with the contents of this FIS and shall not deliver it to any STP initiator port. SMP initiator ports may read the shadow register contents using the SMP REPORT PHY SATA function (see 10.4.3.9). The expander device originates a Broadcast (Change) after receiving the Register - Device to Host FIS (see 7.11).

~~After the Register - Device to Host FIS is accepted, if the SATA device sends a SATA_X_RDY before an affiliation is established, the expander device shall not send SATA_R_RDY.~~

9.3.2 BIST Activate FIS

STP initiator ports and STP target ports shall not generate BIST Activate FISes and shall process any BIST Activate FISes received as frames having invalid FIS types (i.e., have the link layer generate SATA_R_ERR in response).

9.3.3 TT (transport layer for STP ports) state machines

The STP transport layer uses the transport layer state machines defined in SATA, modified to communicate with the port layer rather than directly with the link layer. These modifications are not described in this standard.

10.4.3.7 REPORT PHY SATA function

The REPORT PHY SATA function returns information about the SATA state for a specified phy. This SMP function shall be implemented by SMP target ports that share SAS addresses with STP target ports and by SMP target ports in expander devices with STP/SATA bridges. This SMP function shall not be implemented by any other type of SMP target port.

Table 90 defines the request format.

Table 90 — REPORT PHY SATA request

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (40h)							
1	FUNCTION (12h)							
2	Reserved							
3	REQUEST LENGTH (02h)							
4	Reserved							
8								
9	PHY IDENTIFIER							
10	~~Reserved~~AFFILIATION CONTEXT							
11	Reserved							
12	(MSB)							
15	CRC							(LSB)

The SMP FRAME TYPE field shall be set to 40h.

The FUNCTION field shall be set to 12h.

The REQUEST LENGTH field shall be set to 02h. For compatibility with previous versions of this standard, a REQUEST LENGTH field set to 00h specifies that there are 2 dwords before the CRC field.

The PHY IDENTIFIER field specifies the phy (see 4.2.7) for which information shall be reported.

The AFFILIATION CONTEXT field specifies the relative identifier of the affiliation context for which information shall be reported (see 7.17.5).

The CRC field is defined in 10.4.3.1.

Table 91 defines the response format.

Table 91 — REPORT PHY SATA response (part 1 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (41h)							
1	FUNCTION (12h)							
2	FUNCTION RESULT							
3	RESPONSE LENGTH (~~0Fh~~10h)							
4	(MSB)							
5	EXPANDER CHANGE COUNT							(LSB)
6	Reserved							
8								

Table 91 — REPORT PHY SATA response (part 2 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
9	PHY IDENTIFIER							
10	Reserved							
11	Reserved					STP I_T NEXUS LOSS OCCURRED	AFFILIATIONS SUPPORTED	AFFILIATION VALID
12 to 15	Reserved							
16 to 23	STP SAS ADDRESS							
24 to 43	REGISTER DEVICE TO HOST FIS							
44 to 47	Reserved							
48 to 55	AFFILIATED STP INITIATOR SAS ADDRESS							
56 to 63	STP I_T NEXUS LOSS SAS ADDRESS							
64	Reserved							
65	AFFILIATION CONTEXT							
66	CURRENT AFFILIATION CONTEXTS							
67	MAXIMUM AFFILIATION CONTEXTS							
~~64~~68	(MSB) CRC							
~~67~~71	(LSB)							

The SMP FRAME TYPE field shall be set to 41h.

The FUNCTION field shall be set to 12h.

The FUNCTION RESULT field is defined in 10.4.3.2.

The RESPONSE LENGTH field shall be set to ~~0Fh~~10h. For compatibility with previous versions of this standard, a RESPONSE LENGTH field set to 00h specifies that there are 13 dwords before the CRC field.

The PHY IDENTIFIER field indicates the phy (see 4.2.7) for which information is being reported and is the same as the PHY IDENTIFIER field in the request frame.

An STP I_T NEXUS LOSS OCCURRED bit set to one indicates that the STP target port encountered an I_T nexus loss in the specified affiliation context for the STP initiator port whose SAS address is indicated in the STP I_T NEXUS LOSS SAS ADDRESS field. An STP I_T NEXUS LOSS OCCURRED bit set to zero indicates that:

a) an I_T nexus loss has not occurred in the specified affiliation context;
b) an I_T nexus loss has occurred in the specified affiliation context and been cleared by the SMP PHY CONTROL function CLEAR STP I_T NEXUS LOSS phy operation (see table 4 in 10.4.3.13); or
c) the STP target port has successfully established a connection with the indicated STP initiator port in the specified affiliation context.

An AFFILIATIONS SUPPORTED bit set to one indicates that ~~affiliations are~~ the specified affiliation context is supported by the STP target port containing the specified phy. An AFFILIATIONS SUPPORTED bit set to zero indicates that ~~affiliations are~~ the specified affiliation context is not supported by the STP target port containing the specified phy.

An AFFILIATION VALID bit ~~be~~ set to one indicates that the STP target port is currently maintaining an affiliation in the specified affiliation context and the AFFILIATED STP INITIATOR SAS ADDRESS field is valid ~~and the STP target port containing the specified phy is maintaining an affiliation (see 7.17.5)~~. An AFFILIATION VALID bit set to zero indicates that the STP target port is not currently maintaining an affiliation in the specified affiliation context and the AFFILIATED STP INITIATOR SAS ADDRESS field is not valid ~~that no affiliation is being maintained~~.

The AFFILIATION CONTEXT field indicates the relative identifier of the affiliation context for which affiliation-related information (i.e., the AFFILIATIONS SUPPORTED bit, the AFFILIATION VALID bit, the AFFILIATED STP INITIATOR SAS ADDRESS field, the STP I_T NEXUS LOSS OCCURRED bit, and the STP I_T NEXUS LOSS SAS ADDRESS field) is being reported (see 7.17.5) and is the same as the AFFILIATION CONTEXT field in the request frame.

The CURRENT AFFILIATION CONTEXTS field indicates the current number of affiliations established by the STP target port.

The MAXIMUM AFFILIATION CONTEXTS field indicates the maximum number of affiliation contexts supported by the STP target port.

The STP SAS ADDRESS field contains the SAS address (see 4.2.2) of the STP target port that contains the specified phy.

The REGISTER DEVICE TO HOST FIS field contains the contents of the initial Register - Device to Host FIS. For an STP/SATA bridge, this is delivered by the attached SATA device after a link reset sequence (see ATA/ATAPI-7 V3 and SATAII-EXT). For a native STP target port in an end device, this is directly provided.

The FIS contents shall be stored with little-endian byte ordering (i.e., the first byte, byte 24, contains the FIS Type).

For an STP/SATA bridge, the first byte of the field (i.e., the FIS Type) shall be initialized to zero on power on and whenever the phy has restarted the link reset sequence after losing dword synchronization (see 6.9)(i.e., the SP state machine transitioned from SP22:SATA_PHY_Ready to SP0:OOB_COMINIT (see 6.8)) to indicate the field is invalid and the attached SATA device has not delivered a Register – Device to Host FIS. The first byte of the field shall be set to 34h when the attached SATA device has delivered the initial Register – Device to Host FIS. The remaining contents of the REGISTER DEVICE TO HOST FIS field shall remain constant until a link reset sequence causes the attached SATA device to deliver another initial Register – Device to Host FIS.

An STP/SATA bridge that receives a connection request for a SATA device that has not successfully delivered the initial Register – Device to Host FIS shall return an OPEN_REJECT (NO DESTINATION).

NOTE 1 - If there is a problem receiving the expected initial Register - Device to Host FIS, the STP/SATA bridge should use SATA_R_ERR to retry until it succeeds. In the DISCOVER response, the ATTACHED SATA DEVICE bit is set to one and the ATTACHED SAS ADDRESS field is valid, but the ATTACHED DEVICE TYPE field is set to 000b (i.e., no device attached) during this time.

If the AFFILIATION VALID bit is set to one, t~~T~~he AFFILIATED STP INITIATOR SAS ADDRESS field contains the SAS address (see 4.2.2) of ~~the last~~ the STP initiator port that ~~had~~has an affiliation in the specified affiliation context with the STP target port that contains the specified phy. If the AFFILIATION VALID bit is set to zero, the AFFILIATED STP INITIATOR SAS ADDRESS field may contain the SAS address (see 4.2.2) of an STP initiator port that

previously had an affiliation in the specified affiliation context with the STP target port that contains the specified phy.

The STP I_T NEXUS LOSS SAS ADDRESS field contains the SAS address (see 4.2.2) of the last STP initiator port for which the STP target port experienced an I_T nexus loss (see 4.5) in the specified affiliation context.

The CRC field is defined in 10.4.3.2.

10.4.3.13 PHY CONTROL function

The PHY CONTROL function requests actions by the specified phy. This SMP function may be implemented by any management device server. In zoning expander devices, if zoning is enabled then this function shall only be processed from SMP initiator ports that have access to zone group 2 or the zone group of the specified phy (see 4.9.3.2).

Table 92 defines the request format.

Table 92 — PHY CONTROL request

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (40h)							
1	FUNCTION (91h)							
2	Reserved							
3	REQUEST LENGTH (09h)							
4	(MSB)			EXPECTED EXPANDER CHANGE COUNT				
5								(LSB)
6				Reserved				
8								
9	PHY IDENTIFIER							
10	PHY OPERATION							
11	Reserved							UPDATE PARTIAL PATHWAY TIMEOUT VALUE
12				Reserved				
31								
32	PROGRAMMED MINIMUM PHYSICAL LINK RATE				Reserved			
33	PROGRAMMED MAXIMUM PHYSICAL LINK RATE				Reserved			
34				Reserved				
35								
36	Reserved				PARTIAL PATHWAY TIMEOUT VALUE			
37	~~Reserved~~AFFILIATION CONTEXT							
38				Reserved				
39								
40	(MSB)			CRC				
43								(LSB)

...

Table 93 defines the PHY OPERATION field.

Table 93 — PHY OPERATION field (part 1 of 2)

Code	Operation	Description
00h	NOP	No operation.
01h	LINK RESET	If the specified phy is not a virtual phy, perform a link reset sequence (see 4.4) on the specified phy and enable the specified phy. If the specified phy is a virtual phy, perform an internal reset and enable the specified phy. See 7.11 for BROADCAST (CHANGE) requirements related to this phy operation in an expander device. ~~Any~~All affiliations (see 7.17.5), if any, shall continue to be present. The phy shall bypass the SATA spinup hold state, if implemented (see 6.8.3.9). The SMP response shall be returned without waiting for the link reset to complete.
02h	HARD RESET	If the specified phy is not a virtual phy, perform a link reset sequence (see 4.4) on the specified phy and enable the specified phy. If the attached phy is a SAS phy or an expander phy, the link reset sequence shall include a hard reset sequence (see 4.4.2). If the attached phy is a SATA phy, the phy shall bypass the SATA spinup hold state. See 7.11 for BROADCAST (CHANGE) requirements related to this phy operation in an expander device. If the specified phy is a virtual phy, perform an internal reset and enable the specified phy. ~~Any~~All affiliations (see 7.17.5), if any, shall be cleared. The SMP response shall be returned without waiting for the hard reset to complete.
03h	DISABLE	Disable the specified phy (i.e., stop transmitting valid dwords and receiving dwords on the specified phy). The LINK RESET and HARD RESET operations may be used to enable the phy. See 7.11 for BROADCAST (CHANGE) requirements related to this phy operation in an expander device.
04h	Reserved	
05h	CLEAR ERROR LOG	Clear the error log counters reported in the REPORT PHY ERROR LOG function (see 10.4.3.6) for the specified phy.
06h	CLEAR AFFILIATION	Clear ~~an~~the affiliation (see 7.17.5), if any, from the STP initiator port with the same SAS address as the SMP initiator port that opened this SMP connection. If there is no such affiliation, the SMP target port shall return a function result of SMP FUNCTION FAILED in the response frame.

Table 93 — PHY OPERATION **field** (part 2 of 2)

Code	Operation	Description
07h	TRANSMIT SATA PORT SELECTION SIGNAL	This function shall only be supported by phys in an expander device. If the expander phy incorporates an STP/SATA bridge and supports SATA port selectors, the phy shall transmit the SATA port selection signal (see 6.6) which causes the SATA port selector to select the attached phy as the active host phy and make its other host phy inactive. See 7.11 for BROADCAST (CHANGE) requirements related to this phy operation in an expander device. ~~Any~~All affiliations (see 7.17.5), if any, shall be cleared. If the expander phy does not support SATA port selectors, then the SMP target port shall return a function result of PHY DOES NOT SUPPORT SATA. If the expander phy supports SATA port selectors but is attached to a SAS phy or an expander phy, the SMP target port shall return a function result of SMP FUNCTION FAILED.
08h	CLEAR STP I_T NEXUS LOSS	Clear the STP I_T nexus loss condition reported in the REPORT PHY SATA function for the affiliation context specified in the AFFILIATION CONTEXT field (i.e., set ~~The~~the STP I_T NEXUS LOSS OCCURRED bit to zero in the REPORT PHY SATA function for the specified affiliation context (see 10.4.3.7) ~~shall be set to zero~~).
All others	Reserved	

...

G.1 STP differences from Serial ATA (SATA)

Some of the differences of STP compared with SATA are:

a) STP adds addressing of multiple SATA devices. Each SATA device is assigned a SAS address by its attached expander device with STP/SATA bridge functionality. The STP initiator port understands addressing more than one STP target port;
b) STP allows multiple STP initiator ports to share access to a SATA device behind an STP/SATA bridge using affiliations (see 7.17.5);
c) interface power management is not supported;
d) far-end analog loopback testing is not supported;
e) far-end retimed loopback testing is not supported;
f) near-end analog loopback testing is not supported;
g) use of SATA_CONT is required; and
h) BIST Activate frames are not supported.

G.3 Affiliation policies

G.3.1 Affiliation policies overview

SATA is based on a model that assumes a SATA device is controlled by a single SATA host, and does not address the notion of multiple SATA hosts having the ability to access any given SATA device.

With STP/SATA bridges, SATA devices are cast into an environment where multiple STP initiator ports, by sharing the SATA host port of the STP/SATA bridge, have access to the same SATA device. The SATA protocol used inside STP connections does not account for the possibility that more than one STP initiator port might be vying for access to the SATA device. Affiliations provide a way to ensure contention for a SATA

device does not result in incoherent access to the SATA device when commands from different STP initiator ports collide at the SATA device.

To prevent a SATA device from confusing commands from one STP initiator port with commands from another, an STP initiator port needs a means to maintain exclusive access to a SATA or STP device for the duration of the processing of a command.

For example, consider the case where an STP initiator port establishes a connection to send a command (e.g., a read), and then closes the connection while the SATA device (e.g., a disk drive) retrieves the data (e.g., performs a seek operation to the track containing the data). If, after the connection is closed, another STP initiator port is allowed to establish a connection and send another command, the SATA device would no longer have a means to determine which STP initiator port should receive the data when the device requests the connection to send the data for the first command. This is because, unlike SCSI target devices, SATA devices have no notion of multiple SATA hosts.

The consequences are worse for write commands since the result could be wrong data written to media, with the original data being overwritten and permanently lost.

~~Affiliation provides~~Affliations provide a means for an STP initiator port to establish atomic access to a SATA device across the processing of a command or series of commands to the SATA device, without requiring the STP initiator port to maintain a connection open to the STP target port for the duration of command processing.

G.3.2 Affiliation policy for static STP initiator port to STP target port mapping

Affiliations should not be used to enforce policies establishing fixed associations between STP initiator ports and STP target ports.

G.3.3 Affiliation policy with SATA queued commands and multiple STP initiator ports

When sharing an affiliation context, STP initiator ports using queued commands when other STP initiator ports may be accessing the same STP target port should, at vendor-specific intervals, allow commands to complete and release the affiliation to allow other STP initiator ports access to the STP target port.

G.3.4 Applicability of affiliation for STP target ports

Affiliation may or may not be necessary for STP target ports depending on whether the STP target port tracks the STP initiator port's SAS address on each command received. If the STP target port has the means to manage and track commands from each STP initiator port independently, then affiliations are not necessary because the STP target port is capable of associating each information transfer with the appropriate STP initiator port, and is capable of establishing a connection to the appropriate STP initiator port when sending information back for a command.

An STP target port capable of tracking commands may support a limited number of STP initiator ports (i.e., more than one, but less than one per command) and use multiple affiliations in order to manage that restriction.

An STP target port that behaves the same as a SATA device, in that it maintains only a single ATA task file register ~~image~~context to be shared among all STP initiator ports, supports a single affiliation~~s~~ in order to provide a way for STP initiator ports to maintain exclusive access to the STP target port while commands remain outstanding. In this model, an STP target port is capable of establishing connections to an STP initiator port, but is only capable of remembering the SAS address of the last STP initiator port to establish a connection, and therefore is only capable of requesting a connection back to that same STP initiator port.

See 10.4.3.7 for an explanation of how an STP target port reports support for affiliations.