To: T10 Technical Committee
From: Steven Fairchild, HP (steve.Fairchild@hp.com)
Date: 26 July 2002
Subject: Proposal to allow an initiator based configuration of the SAS topology

Revision r2:

- Cleanup pass on Open, Identify and SMP commands that have common payloads to maximize re-use (requested by BREA).
- Removed Edge Route device type in favor of making a device type "configurable". Report General will report whether or not a device is configurable (because of general comments received).
- Added definition of **ASSIGNED** field, which means the field position has been assigned to or defined by another command or frame, which re-uses this frame's structure either partially or in its entirety. Unlike a **RESERVED** field, this field may contain non-0 values, but shall not be redefined or reused. The receiver shall ignore an **ASSIGNED** field. This could just as easily be converted to **RESTRICTED** if that definition is more appropriate.
- Added FUNCTION to SMP response frame so that analyzers can more easily decode response frames (requested by I-TECH).

Revision r1:

- Identify address frame now includes two SAS addresses, one for this phy, and one for the far end phy, placed in the same positions are they occur in the Open address frame. The Discover, Report Route Information, and Configure Route Information have the same change.
- Identify address frame has wording that indicates [prog] min/max phy link rate field(s) may be reported as rate unknown.

This is a multi-part proposal that:

- Modifies the Identify Frame format.
- Modifies the SMP Request/Response format.
- Modifies the SMP Discover function to re-use the Identify Frame payload and support a shift in discovery from a "by Expander" mechanism to a "by Phy" mechanism.
- Modifies the SMP Report General function to remove the bit mask fields and add route fields and a configuration bit.
- Deletes the SMP functions; Report Phy and Report Phy Device Names, because their information is provided in the modified Discover payload.
- Adds the SMP functions; Report Route Information and Configure Route Information, to facilitate the implementation of an initiator based topology discovery.
- Add an addendum for guidelines on how an initiator can discover and configure the topology.

Background

The purpose for the recommended changes is to reduce the complexity of the expander devices and improve topology error detection. Additionally an addendum is provided that will allow the configuration of edge and fanout devices by one or more initiators.

In the current SAS specification, discovery is on a “by Expander” basis. The recommendation is to change this to a “by Phy” basis so that expander devices are not required to consolidate information across multiple phys. This will reduce the expander complexity and increase the flexibility available in building the expander devices.

Also, the current SAS specification imposes rules about the number of edge devices or fanout devices that may be connected to each other, implying that topologies will fail if the rules are broken. The recommendation is to not restrict the interconnection of any end, edge or fanout device. During Discovery, when an initiator determines that an illegal topology has been created, it may take appropriate action. Disabling illegal links and reporting un-reachable SAS addresses as necessary.

Comparison of frame layout for common or overloaded fields

	Open Address Frame	Identify Address Frame		SMP Discover SMP Report General SMP Report Route SMP Configure Route SMP Phy Control SMP Phy Margin Control
			0	REQUEST (40H) / RESPONSE (41H)
			1	FUNCTION
			2	RESULT
			3	RESERVED
			4 5	ROUTE SLOT / MAX ROUTE SLOT
			6 7	ROUTE INDEX /MAX ROUTE INDEX
			8	RESERVED
			9	PHY IDENTIFIER / NUMBER OF PHYS
			10	PHY OPERATION / CONFIGURE ROUTE [0]
			11	RESERVED
0	INITIATOR [7] PROTOCOL [4:6] ADDRESS FRAME TYPE [0:3]	ASSIGNED [7] DEVICE TYPE [4:6] ADDRESS FRAME TYPE [0:3]	12	ROUTE [7] DEVICE TYPE [4:6] ADDRESS DECODE [0:3]
1	FEATURES [4:7] LINK RATE [0:3]	ASSIGNED [4:7] PHY LINK RATE [0:3]	13	LINK STATE [4:6] PHY LINK RATE [0:3]
2 3	INITIATOR CONNECTION TAG	RESERVED [4:7] SSP INITIATOR [3] STP INITIATOR [2] SMP INITIATOR [1] RESERVED [0]	14	RESERVED [4:7] SSP INITIATOR [3] STP INITIATOR [2] SMP INITIATOR [1] RESERVED [0]
		RESERVED [4:7] SSP TARGET [3] STP TARGET [2] SMP TARGET [1] ASSIGNED [0]	15	RESERVED [4:7] SSP TARGET [3] STP TARGET [2] SMP TARGET [1] SATA TARGET [0]
4 11	DESTINATION SAS ADDRESS	ASSIGNED	16 23	FAR END SAS ADDRESS
12 19	SOURCE SAS ADDRESS	SAS ADDRESS	24 31	SAS ADDRESS
20	RESERVED	ASSIGNED	32	PROG MIN PHY RATE [4:7] MIN PHY RATE [0:3]
21	*'PBC'*		33	PROG MAX PHY RATE [4:7] MAX PHY RATE [0:3]
22 23	ARBITRATION WAIT TIME		34 35	VENDOR-SPECIFIC
24 27	RESERVED	RESERVED	36 39	RESERVED
28 31	CRC	CRC	40 43	CRC

	SMP Discover		SMP Report General	
0	REQUEST (40H)	RESPONSE (41H)	REQUEST (40H)	RESPONSE (41H)
1	FUNCTION (00H)	FUNCTION (00H)	FUNCTION (01H)	FUNCTION (01H)
2	RESERVED	RESULT (00H)	RESERVED	RESULT (00H)
3		RESERVED		RESERVED
4	ASSIGNED	ASSIGNED	ASSIGNED	MAXIMUM ROUTE SLOT
5				
6				MAXIMUM ROUTE INDEX
7				
8	RESERVED	RESERVED	RESERVED	RESERVED
9	PHY IDENTIFIER	PHY IDENTIFIER	ASSIGNED	NUMBER OF PHYS
10	ASSIGNED	ASSIGNED		RESERVED [1:7] CONFIGURE ROUTE [0]
11	RESERVED	RESERVED	RESERVED	RESERVED
12	CRC	ROUTE [7] DEVICE TYPE [4:6] ADDRESS DECODE [0:3]	CRC	CRC
13		RESERVED [7] LINK STATE [4:6] PHY LINK RATE [0:3]		
14		RESERVED [4:7] SSP INITIATOR [3] STP INITIATOR [2] SMP INITIATOR [1] RESERVED [0]		
15		RESERVED [4:7] SSP TARGET [3] STP TARGET [2] SMP TARGET [1] SATA TARGET [0]		
16		FAR END SAS ADDRESS		
23				
24		SAS ADDRESS		
31				
32		PROG MIN PHY RATE [4:7] MIN PHY RATE [0:3]		
33		PROG MAX PHY RATE [4:7] MAX PHY RATE [0:3]		
34		ASSIGNED		
35				
36		RESERVED		
39				
40		CRC		
43				

	SMP Report SATA Capabilities		SMP Manufacturer Information	
0	REQUEST (40H)	RESPONSE (41H)	REQUEST (40H)	RESPONSE (41H)
1	FUNCTION (02H)	FUNCTION (02H)	FUNCTION (03H)	FUNCTION (03H)
2	RESERVED	RESULT (00H)	RESERVED	RESULT (00H)
3		RESERVED		RESERVED
4 7	CRC	ASSIGNED	CRC	ASSIGNED
8		RESERVED		RESERVED
9 10		ASSIGNED		ASSIGNED
11		RESERVED		RESERVED
12		RESERVED [2:7] ATA QUEUING CAPABLE [1] SATA CAPABLE [0]		VENDOR IDENTIFICATION
13 15		RESERVED		
16		NUMBER OF INITIATORS		
17		SATA VERSION		
18 19		RESERVED		
20 23		CRC		PRODUCT IDENTIFICATION
24 35				
36 39				PRODUCT REVISION LEVEL
40 59				VENDOR-SPECIFIC
60 63				CRC

	SMP Report Phy Error Log		SMP Phy SATA	
0	REQUEST (40H)	RESPONSE (41H)	REQUEST (40H)	RESPONSE (41H)
1	FUNCTION (11H)	FUNCTION (11H)	FUNCTION (12H)	FUNCTION (12H)
2	RESERVED	RESULT (00H)	RESERVED	RESULT (00H)
3		RESERVED		RESERVED
4 7	ASSIGNED	ASSIGNED	ASSIGNED	ASSIGNED
8	RESERVED	RESERVED	RESERVED	RESERVED
9	PHY IDENTIFIER	PHY IDENTIFIER	PHY IDENTIFIER	PHY IDENTIFIER
10	ASSIGNED	ASSIGNED	ASSIGNED	ASSIGNED
11	RESERVED	RESERVED	RESERVED	RESERVED
12 15	CRC	INVALID CHARACTER COUNT	CRC	REGISTER DEVICE TO HOST FIS
16 19		DISPARITY ERROR COUNT		
20 23		LOSS OF BIT SYNC COUNT		
24 27		CRC		
28 31				
32 35				CRC

	SMP Report Route		SMP Configure Route	
0	REQUEST (40H)	RESPONSE (41H)	REQUEST (40H)	RESPONSE (41H)
1	FUNCTION (04H)	FUNCTION (04H)	FUNCTION (80H)	FUNCTION (80H)
2	RESERVED	RESULT (00H)	RESERVED	RESULT (00H)
3		RESERVED		RESERVED
4 5	ROUTE SLOT	ROUTE SLOT	ROUTE SLOT	CRC
6 7	ROUTE INDEX	ROUTE INDEX	ROUTE INDEX	
8	RESERVED	RESERVED	RESERVED	
9 10	ASSIGNED	ASSIGNED	ASSIGNED	
11	RESERVED	RESERVED	RESERVED	
12	CRC	ROUTE [7] ASSIGNED [0:6]	ROUTE [7] ASSIGNED [0:6]	
13 15		ASSIGNED	ASSIGNED	
16 23		FAR END SAS ADDRESS	FAR END SAS ADDRESS	
24 35		ASSIGNED	ASSIGNED	
36 39		RESERVED	RESERVED	
40 43		CRC	CRC	

	SMP Phy Control		SMP Phy Margin Control	
0	REQUEST (40H)	RESPONSE (41H)	REQUEST (40H)	RESPONSE (41H)
1	FUNCTION (90H)	FUNCTION (90H)	FUNCTION (91H)	FUNCTION (91H)
2	RESERVED	RESULT (00H)	RESERVED	RESULT (00H)
3		RESERVED		RESERVED
4 7	ASSIGNED	CRC	ASSIGNED	ASSIGNED
8	RESERVED		RESERVED	RESERVED
9	PHY IDENTIFIER		PHY IDENTIFIER	PHY IDENTIFIER
10	PHY OPERATION		ASSIGNED	ASSIGNED
11	RESERVED		RESERVED	RESERVED
12 15	ASSIGNED		ASSIGNED	ASSIGNED
16 31				
32	PROG MIN PHY RATE [4:7] ASSIGNED [0:3]			
33	PROG MAX PHY RATE [4:7] ASSIGNED [0:3]			
34 35	ASSIGNED		VENDOR-SPECIFIC	VENDOR-SPECIFIC
36 39	RESERVED		RESERVED	RESERVED
40 43	CRC		CRC	CRC

Change 1: Modify the Identify Frame format

from:

Byte	7	6	5	4	3	2	1	0
0	Reserved				ADDRESS FRAME TYPE (0h)			
1	PHY IDENTIFIER							
2	Reserved				MAXIMUM PHYSICAL LINK RATE			
3	DEVICE TYPE		STP INITIATOR	STP TARGET	SSP INITIATOR	SSP TARGET	SMP INITIATOR	SMP TARGET
4	DEVICE NAME							
11								
12	(MSB)	Reserved						
27								(LSB)
28	(MSB)	CRC						
31								(LSB)

to:

Byte	7	6	5	4	3	2	1	0
0	Assigned	DEVICE TYPE			ADDRESS FRAME TYPE (0h)			
1	Assigned				PHY LINK RATE			
2	Reserved				SSP INITIATOR	STP INITIATOR	SMP INITIATOR	Reserved
3	Reserved				SSP TARGET	STP TARGET	SMP TARGET	Assigned
4	Assigned							
11								
12	(MSB)	SAS ADDRESS						
19								(LSB)
20	Assigned							
21								
22	Reserved							
27								
28	(MSB)	CRC						
31								(LSB)

The ADDRESS FRAME TYPE field as defined in sas-00.

The DEVICE TYPE field as defined in sas-00, with the exception of an increase from a 2-bit field to a 3-bit field.

The PHY LINK RATE field indicates the current physical link rate negotiated on this phy and is defined in Table 1.

Table 1. Physical Link Rate

PHY LINK RATE	Physical link rate
0000b – 0010b	Assigned
0011b	1,5 Gbps
0100b	3,0 Gbps
0101b – 1111b	Reserved

The SMP INITIATOR bit as defined in sas-00.

The STP INITIATOR bit as defined in sas-00.

The SSP INITIATOR bit as defined in sas-00.

The SMP TARGET bit as defined in sas-00.

The STP TARGET bit as defined in sas-00.

The SSP TARGET bit as defined in sas-00.

The SAS ADDRESS field as defined in sas-00.

Change 2: Modify the SMP Request/Response Format

from:

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	Reserved							
23								
24	FUNCTION							
25	ADDITIONAL REQUEST BYTES							
m								
	Fill bytes, if needed							
n - 3	(MSB)	CRC						
n								(LSB)

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	Reserved							
23								
24	FUNCTION RESULT							
25	ADDITIONAL RESPONSE BYTES							
m								
	Fill bytes, if needed							
n - 3	(MSB)	CRC						
n								(LSB)

to:

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION							
2	Reserved							
3								
4	ADDITIONAL REQUEST BYTES							
m								
	Fill bytes, if needed							
n - 3	(MSB)	CRC						
n								(LSB)

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION							
2	RESULT							
3	Reserved							
4	ADDITIONAL RESPONSE BYTES							
m								
	Fill bytes, if needed							
n - 3	(MSB)	CRC						
n								(LSB)

Note: The reason for the change is to reduce the overall size of the SMP payload. This change is not critical to the overall proposal. If accepted, then all SMP request and response frames will need to be adjusted. The editing involved in not reflected in this proposal. There is also a change to add the FUNCTION requested to the response, primarily to support analysis tools that may need to analyze a response frame independent of the request.

Change 3: Modify the SMP Discover Format

Editorial note: The current version of SAS drops the header bytes in the presentation of the functions. This makes it look like the fields in the frames are not on appropriate word boundaries. Would like to suggest that the single byte that is the information unit type be included in the descriptions so that boundaries are presented properly. The proposal changes the tables to this format.

from:

The Discover function returns the SAS Addresses attached to a device. This function shall be implemented by all expander devices and may be implemented by other types of devices.

Table x defines the request format.

Table x. DISCOVER request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (00h)							
1	Reserved							
3								

Table y defines the response format.

Table y. DISCOVER response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	Reserved							
3								
4	(MSB)	DEVICE NAME VALID BITMASK						
11								(LSB)
12	(MSB)	ATTACHED FANOUT EXPANDER BITMASK						
19								(LSB)
20	Reserved							
31								
32	(MSB)	DEVICE NAME 0						
39								(LSB)
…	…							
536	(MSB)	DEVICE NAME 63						
543								(LSB)
544	(MSB)	CRC						
547								(LSB)

to:

The DISCOVER function returns the physical link configuration information for the physical link specified. This function shall be implemented by all expander devices and may be implemented by other types of devices. The physical link configuration information provides details about the far end device SAS address, the state of the physical link, the protocols supported by the far end device, the link rate and the addressing support provided by the physical link.

Table x defines the request format.

Table x. DISCOVER request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (00h)							
2	Reserved							
3								
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	(MSB) CRC							
15								(LSB)

The PHY IDENTIFIER field indicates the physical link for which the physical link configuration information is being requested.

Table y defines the response format.

Table y. DISCOVER response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (00h)							
2	RESULT							
3	Reserved							
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	ROUTE	DEVICE TYPE			ADDRESS DECODE			
13	Reserved	LINK STATE			PHY LINK RATE			
14	Reserved				SSP INITIATOR	STP INITIATOR	SMP INITIATOR	Reserved
15	Reserved				SSP TARGET	STP TARGET	SMP TARGET	SATA TARGET
16	(MSB) FAR END SAS ADDRESS							
23								(LSB)
24	(MSB) SAS ADDRESS							
31								(LSB)
32	PROG MIN PHY RATE				MIN PHY RATE			
33	PROG MAX PHY RATE				MAX PHY RATE			
34	Assigned							
35								
36	Reserved							
39								
40	(MSB) CRC							
43								(LSB)

The PHY IDENTIFIER field indicates the physical link for which the physical configuration link information is being requested.

The ADDRESS DECODE field indicates the method of address decode supported by this phy and is defined in Table 1. A device which is capable of supporting multiple decode mechanisms should report the most capable method. Table decode is the most capable, Subtractive decode is the least capable.

Table 1. Address Decode

ADDRESS DECODE	Address Decode
000b	None
001b	Subtractive
010b	Table
011b-111b	Reserved

Phys defined as ‘None’ address decode shall not be used to route any SAS Address.

Phys defined as ‘Subtractive’ address decode shall be used to route any SAS Address that is not resolved within the expander component. When multiple phys within an expander component are defined as ‘Subtractive’ they must terminate at far end phys with identical SAS Addresses, defining a single wide SAS port.

Phys defined as ‘Table’ address decode shall have a route vector table associated with them that shall contain SAS Addresses that may be resolved at or beyond the far end phy. Only SAS Addresses with references in the associated vector table may be routed out this phy. Elements of the route vector table may be queried and updated by the ROUTE INDEX and ROUTE SLOT variables in the REPORT ROUTE INFORMATION and CONFIGURE ROUTE INFORMATION functions.

The DEVICE TYPE field as defined in sas-00, with the exception of an increase from a 2-bit field to a 3-bit field.

The ROUTE field indicates the content of the frame is valid for routing. The 0b value indicates the route has been determined to be in violation of connection rules.

The PHY LINK RATE field indicates the current physical link rate negotiated on this phy and is defined in Table 2.

Table 2. Physical Link Rate

PHY LINK RATE	Physical link rate
0000b	Rate unknown
0001b	Phy does not exist
0010b	Phy disabled
0011b	1,5 Gbps
0100b	3,0 Gbps
0101b – 1111b	Reserved

The LINK STATE field indicates the current state of the physical link on this phy.

Table 3. Link State

LINK STATE	Link State
000b	Active
001b	Inactive
010b	Failed
011b	OOB in Progress
100b	Spinup Hold OOB
101b – 111b	Reserved

The SMP INITIATOR bit as defined in sas-00.

The STP INITIATOR bit as defined in sas-00.

The SSP INITIATOR bit as defined in sas-00.

The SATA TARGET bit indicates the far end device is an SATA target device.

The SMP TARGET bit as defined in sas-00.

The STP TARGET bit as defined in sas-00.

The SSP TARGET bit as defined in sas-00.

The SAS ADDRESS field as defined in sas-00.

The FAR END SAS ADDRESS field contains the device name for the far end phy.

The SAS ADDRESS field contains the device name of this phy.

The MIN PHY RATE field indicates the minimum physical link rate supported on this phy and is defined in Table 2.

The PROG MIN PHY RATE field indicates the minimum physical link rate programmed on this phy and is defined in Table 2.

The MAX PHY RATE field indicates the maximum physical link rate supported on this phy and is defined in Table 2.

The PROG MAX PHY RATE field indicates the maximum physical link rate programmed on this phy and is defined in Table 2.

Change 4: Modify the SMP Report General format

from:

Table x defines the request format.

Table x. REPORT GENERAL request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (01h)							
1	Reserved							
3								

Table y defines the response format.

Table y. REPORT GENERAL response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	Reserved							
2	NUMBER OF PHYS							
3	INPUT PHY IDENTIFIER							
4	Reserved							
15								
16	(MSB)	ACTIVE PHY BITMASK						
23								(LSB)
24	(MSB)	ATTACHED FANOUT EXPANDER BITMASK						
31								(LSB)
32	(MSB)	ATTACHED EDGE EXPANDER BITMASK						
39								(LSB)
40	(MSB)	ATTACHED SAS INITIATOR BITMASK						
47								(LSB)
48	(MSB)	ATTACHED SAS TARGET BITMASK						
53								(LSB)
54	(MSB)	ATTACHED SATA BITMASK						
75								(LSB)
76	(MSB)	PHY RATE MULTIBITMASK						
83								(LSB)
84	(MSB)	FUNCTIONS SUPPORTED BITMASK						
115								(LSB)

to:

Table x defines the request format.

Table x. REPORT GENERAL request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (01h)							
2	Reserved							
3								
4	CRC							
7								

Table y defines the response format.

Table y. REPORT GENERAL response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (01h)							
2	RESULT							
3	Reserved							
4	(MSB) MAXIMUM ROUTE SLOT							
5								(LSB)
6	(MSB) MAXIMUM ROUTE INDEX							
7								(LSB)
8	Reserved							
9	NUMBER OF PHYS							
10	Reserved							CONFIGURE ROUTE
11	Reserved							
12	(MSB) CRC							
15								(LSB)

The MAXIMUM ROUTE SLOT field contains the maximum number of route slots for an expander device. If defined, the number of route slots shall be at least equal to the number of phys on the expander device. A value of 0 indicates that no route table is defined.

The MAXIMUM ROUTE INDEX field contains the maximum number of route indexes for an expander device. If defined, the number of route indexes shall be greater than or equal to the number of phys on the far end device for an edge device or shall be greater than or equal to the maximum supported devices in an edge cloud for a fanout device (currently this is 64).

The NUMBER OF PHYS field contains the number of phys in the device.

The CONFIGURE ROUTE field indicates whether the expander device has a configurable route table. An expander device with a configurable route table shall have this bit set and shall have defined values for the MAXIMUM ROUTE SLOT and MAXIMUM ROUTE INDEX. Refer to addendum X for information on how to configure the route table for an expander device with this bit set. An expander device without a configurable route table shall have this bit cleared. An expander device may have a route table that may be interrogated, but not configured.

Change 5: Delete the SMP functions; Report Phy and Report Phy Devices

Note: These functions are no longer needed; because their functionality has been consolidated into the Identify frame and Discover response.

Change 6: Modify the SMP function, Report SATA Capabilities

from:

Table x defines the request format.

Table x. REPORT SATA CAPABILITIES request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (02h)							
1	Reserved							
3								

Table y defines the response format.

Table y. REPORT SATA CAPABILITIES response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	Reserved						ATA QUEUING CAPABLE	SATA CAPABLE
2	SATA VERSION							
3	NUMBER OF INITIATOR PORTS							

to:

Table x defines the request format.

Table x. REPORT SATA CAPABILITIES request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (02h)							
2	Reserved							
3								
4	CRC							
7								

Table y defines the response format.

Table y. REPORT SATA CAPABILITIES response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (02h)							
2	RESULT							
3	Reserved							
4	Assigned							
7								
8	Reserved							
9	Assigned							
10								
11	Reserved							
12	Reserved						ATA QUEUEING CAPABLE	SATA CAPABLE
13	Reserved							
15								
16	NUMBER OF INITIATORS							
17	SATA VERSION							
18	Reserved							
19								
20	(MSB) CRC							
23								(LSB)

The SATA CAPABLE bit as defined in sas-00.

The ATA QUEUEING CAPABLE bit as defined in sas-00.

The NUMBER OF INITIATORS field as defined in sas-00.

The SATA VERSION field as defined in sas-00. Note: Since the version designations and features in SATA are blurred from a technical and market perspective. I would suggest a feature bit list only and no reliance on a SATA version. I anticipate that SATA VERSION will end up being a useless field after a couple of generations. I did not suggest a change here only because it was not significant for the proposal.

Change 7: Modify the SMP function, Report Manufacturer Information

from:

Table x defines the request format.

Table x. REPORT MANUFACTURER INFORMATION request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (03h)							
1	Reserved							
3								

Table y defines the response format.

Table y. REPORT MANUFACTURER INFORMATION response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	Reserved							
3								
4	ADDITIONAL LENGTH (33h)							
5	Reserved							
7								
8	(MSB)	VENDOR IDENTIFICATION						
15								(LSB)
16	(MSB)	PRODUCT IDENTIFICATION						
31								(LSB)
32	(MSB)	PRODUCT REVISION LEVEL						
35								(LSB)
36	Vendor-specific							
55								

to:

Table x defines the request format.

Table x. REPORT MANUFACTURER INFORMATION request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (03h)							
2	Reserved							
3								
4	CRC							
7								

Table y defines the response format.

Table y. REPORT MANUFACTURER INFORMATION response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (03h)							
2	RESULT							
3	Reserved							
4	Assigned							
7								
8	Reserved							
9	Assigned							
10								
11	Reserved							
12	VENDOR INFORMATION							
19								
20	PRODUCT IDENTIFICATION							
35								
36	PRODUCT REVISION LEVEL							
39								
40	Vendor-Specific							
59								
60	(MSB)	CRC						
63								(LSB)

The VENDOR INFORMATION field as defined in sas-00.

The PRODUCT IDENTIFICATION field as defined in sas-00.

The PRODUCT REVISION LEVEL field as defined in sas-00.

Change 8: Modify the SMP function, Report Phy Error Log

from:

Table x defines the request format.

Table x. REPORT PHY ERROR LOG request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (11h)							
1	Reserved							
2								
3	PHY IDENTIFIER							

Table y defines the response format.

Table y. REPORT PHY ERROR LOG response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	REPORT PHY ERROR LOG RESULT							
2	Reserved							
3								
4	(MSB)	INVALID CHARACTER COUNT						
7								(LSB)
8	(MSB)	DISPARITY ERROR COUNT						
11								(LSB)
12	(MSB)	LOSS OF BIT SYNCHRONIZATION COUNT						
15								(LSB)

to:

Table x defines the request format.

Table x. REPORT PHY ERROR LOG request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (11h)							
2	Reserved							
3								
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	CRC							
15								

Table y defines the response format.

Table y. REPORT PHY ERROR LOG response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (11h)							
2	RESULT							
3	Reserved							
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	INVALID CHARACTER COUNT							
15								
16	DISPARITY ERROR COUNT							
19								
20	LOSS OF BIT SYNC COUNT							
23								
24	(MSB) CRC							
27								(LSB)

The PHY IDENTIFIER field as defined in sas-00.

The INVALID CHARACTER COUNT field as defined in sas-00.

The DISPARITY ERROR COUNT field as defined in sas-00.

The LOSS OF BIT SYNC COUNT field as defined in sas-00.

Change 9: Modify the SMP function, Report Phy SATA

from:

Table x defines the request format.

Table x. REPORT PHY SATA request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (12h)							
1	Reserved							
2								
3	PHY IDENTIFIER							

Table y defines the response format.

Table y. REPORT PHY SATA response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	REPORT PHY SATA RESULT							
2	Reserved							
3	Reserved							
4	REGISTER DEVICE TO HOST FIS							
23								

to:

Table x defines the request format.

Table x. REPORT PHY SATA request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (12h)							
2	Reserved							
3								
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	CRC							
15								

Table y defines the response format.

Table y. REPORT PHY SATA response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (12h)							
2	RESULT							
3	Reserved							
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	REGISTER DEVICE TO HOST FIS							
31								
32	(MSB)	CRC						
35								(LSB)

The PHY IDENTIFIER field as defined in sas-00.

The REGISTER DEVICE TO HOST FIS field as defined in sas-00.

Change 10: Add the SMP function, Report Route Information

The REPORT ROUTE INFORMATION function returns the route table information for a specific route slot and route index within an expander device. Expander devices shall support this function if the Report General function has defined values for MAXIMUM ROUTE SLOT and MAXIMUM ROUTE INDEX. This function is used primarily as a diagnostic tool to resolve topology issues.

Table x defines the request format.

Table x. REPORT ROUTE INFORMATION request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (04h)							
2	Reserved							
3								
4	(MSB)	ROUTE SLOT						
5								(LSB)
6	(MSB)	ROUTE INDEX						
7								(LSB)
8	Reserved							
9	Assigned							
10								
11	Reserved							
12	CRC							
15								

The ROUTE SLOT field indicates the route slot for which the Report Route information is being requested. The value must be in the range of 0 to MAXIMUM ROUTE SLOT or a function reject response shall occur.

The ROUTE INDEX field indicates the route index for which the Report Route information is being requested. The value must be in the range of 0 to MAXIMUM ROUTE INDEX or a function reject response shall occur.

Table y defines the response format.

Table y. REPORT ROUTE INFORMATION response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (04h)							
2	RESULT							
3	Reserved							
4	(MSB)							
5	ROUTE SLOT							(LSB)
6	(MSB)							
7	ROUTE INDEX							(LSB)
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	ROUTE	Assigned						
13	Assigned							
15								
16	(MSB)							
23	FAR END SAS ADDRESS							(LSB)
24	Assigned							
35								
36	Reserved							
39								
40	(MSB)							
43	CRC							(LSB)

The ROUTE SLOT field indicates the route slot for which the Report Route information has been requested. The ROUTE INDEX field indicates the route index for which the Report Route information has been requested.

The PHY IDENTIFIER field indicates the physical link for which the Discover information is being requested.

The ROUTE field indicates the content of the frame is valid for routing. The 0b value indicates the route has been determined to be in violation of connection rules.

The FAR END SAS ADDRESS field contains the device name for the far end phy.

Change 11: Add the SMP function, Configure Route Information

The CONFIGURE ROUTE INFORMATION function sets the route table information for a specific route slot and route index within a configurable expander device. Expander devices that do not have a configurable route table or end devices do not need to support this function. Expander devices shall support this function if the Report General function has the CONFIGURE ROUTE field set.

Table x defines the request format.

Table x. CONFIGURE ROUTE INFORMATION request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (80h)							
2	Reserved							
3								
4	(MSB)	ROUTE SLOT						
5								(LSB)
6	(MSB)	ROUTE INDEX						
7								(LSB)
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	ROUTE	Assigned						
13	Assigned							
15								
16	(MSB)	FAR END SAS ADDRESS						
23								(LSB)
24	Assigned							
35								
36	Reserved							
39								
40	(MSB)	CRC						
43								(LSB)

The ROUTE SLOT field indicates the route slot for which the Configure Route information is being configured. The value must be in the range of 0 to MAXIMUM ROUTE SLOT or a function reject response shall occur.

The ROUTE INDEX field indicates the route index for which the Configure Route information is being configured. The value must be in the range of 0 to MAXIMUM ROUTE INDEX or a function reject response shall occur.

The PHY IDENTIFIER field indicates the physical link for which the Discover information is being requested.

The ROUTE field indicates the content of the frame is valid for routing. The 0b value indicates the route has been determined to be in violation of connection rules.

The FAR END SAS ADDRESS field contains the device name for the far end phy.

Table y defines the response format.

Table y. CONFIGURE ROUTE INFORMATION response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (80h)							
2	RESPONSE							
3	Reserved							
4	CRC							
7								

Change 12: Modify SMP function Phy Control

from:

Table x defines the request format.

Table x. PHY CONTROL request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (90h)							
1	Reserved							
2								
3	PHY IDENTIFIER							
4	PHY OPERATION							
5	MINIMUM PHYSICAL LINK RATE				MAXIMUM PHYSICAL LINK RATE			
6	Reserved							
7								

Table y defines the response format.

Table y. PHY CONTROL response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	PHY CONTROL RESULT							
2	Reserved							
3	Reserved							

to:

Table x defines the request format.

Table x. PHY CONTROL request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (90h)							
2	Reserved							
3								
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	PHY OPERATION							
11	Reserved							
12	Assigned							
31								
32	PROG MIN PHY RATE				Assigned			
33	PROG MAX PHY RATE				Assigned			
34	Assigned							
35								
36	Reserved							
39								
40	CRC							
43								

The PHY IDENTIFIER field as defined in sas-00.

The PHY OPERATION field as defined in sas-00.

The PROG MIN PHY RATE field indicates the minimum physical link rate programmed on this phy and is defined in Table 1.

The PROG MAX PHY RATE field indicates the maximum physical link rate programmed on this phy and is defined in Table 1.

Table 1. Physical Link Rate

PHY LINK RATE	Physical link rate
0000b	Rate unknown
0001b	Phy does not exist
0010b	Phy disabled
0011b	1,5 Gbps
0100b	3,0 Gbps
0101b – 1111b	Reserved

Table y defines the response format.

Table y. PHY CONTROL response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (90h)							
2	RESPONSE							
3	Reserved							
4	CRC							
7								

Change 13: Modify SMP function Phy Margin Control

from:

Table x defines the request format.

Table x. PHY MARGIN CONTROL request

Byte	7	6	5	4	3	2	1	0
0	FUNCTION (91h)							
1	Reserved							
2								
3	PHY IDENTIFIER							
4	Reserved							
5	Reserved							
6	Vendor-specific							
7	Vendor-specific							

Table y defines the response format.

Table y. PHY MARGIN CONTROL response

Byte	7	6	5	4	3	2	1	0
0	FUNCTION RESULT							
1	PHY CONTROL RESULT							
2	Reserved							
3	Reserved							

to:

Table x defines the request format.

Table x. PHY MARGIN CONTROL request

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (40h)							
1	FUNCTION (91h)							
2	Reserved							
3								
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	Assigned							
33								
34	Vendor-Specific							
35								
36	Reserved							
39								
40	CRC							
43								

The PHY IDENTIFIER field as defined in sas-00.

Table y defines the response format.

Table y. PHY MARGIN CONTROL response

Byte	7	6	5	4	3	2	1	0
0	INFORMATION UNIT TYPE (41h)							
1	FUNCTION (91h)							
2	Reserved							
3								
4	Assigned							
7								
8	Reserved							
9	PHY IDENTIFIER							
10	Assigned							
11	Reserved							
12	Assigned							
33								
34	Vendor-Specific							
35								
36	Reserved							
39								
40	CRC							
43								

The PHY IDENTIFIER field as defined in sas-00.

Change 14: Definitions and discover rules

define:

configurable expander component: An expander component that contains a route table that must be populated with route information to function within an expander device.

expander component: One or more discrete physical devices that interconnect cooperatively to provide the port count of an expander device.

change:

7.6.2 Initiator device specific rules

After identifying that it is attached to an expander device after a link reset sequence, or after receiving a CHANGE primitive sequence, an initiator port should perform a level-order traversal of the domain by opening an SMP connection to each expander device and use the DISCOVER function (see 9.4.4.2) to retrieve a list of attached SAS addresses. The order of traversal should be:

1) expander device to which the initiator port is attached;
2) every device attached to that expander device; and
3) if another expander device is found, every device attached to that expander device.

When this is done after a link reset sequence, this lets the initiator discover information about all the devices in the domain. When this is done after a CHANGE, this lets the initiator port determine what changed in the domain.

This information may be used to select link rates for connection requests.

to:

7.6.2 Initiator device specific rules

After identifying that it is attached to an expander device after a link reset sequence, or after receiving a CHANGE primitive sequence, an initiator port should perform a level-order traversal of the domain by opening an SMP connection to each expander device and use the DISCOVER function (see 9.4.4.2) to retrieve the far end SAS address of each phy. The order of traversal should be:

1) expander device to which the initiator port is attached;
2) every device attached to that expander device; and
3) if another expander device is found, every device attached to that expander device.

When this is done after a link reset sequence, this lets the initiator discover information about all the devices in the domain. When this is done after a CHANGE, this lets the initiator port determine what changed in the domain.

This information may be used to select link rates for connection requests.

change:

7.6.3 Fanout expander device specific rules

After learning that it is attached to an edge expander device, a fanout expander device shall use the SMP DISCOVER function (see 9.4.4.2) to retrieve the list of SAS addresses to which the edge expander device is attached.

After receiving a CHANGE primitive sequence from an edge expander device, the fanout expander device shall use the SMP DISCOVER function to obtain an updated list of SAS addresses from that edge expander device.

to:

7.6.3 Fanout expander device specific rules

After learning that it is attached to an edge expander device, a fanout expander device may use the SMP DISCOVER function (see 9.4.4.2) to retrieve the far end SAS address of each phy within an edge expander device.

After receiving a CHANGE primitive sequence from an edge expander device, the fanout expander device may use the SMP DISCOVER function to obtain the updated far end SAS address of each phy within an edge expander device.

Change 15: Guidelines for an initiator to discover and configure the SAS topology

To simplify the edge expander devices and fanout expander devices within the SAS topology, it is desirable to provide a mechanism for initiators to configure the topology. The algorithm presented defines a method where any and all initiators in the topology may configure the topology without requiring any form of coordination between the initiators.

There are two major components of the algorithm; the method used to traverse the topology and the mechanism used to update the route information in the topology.

The initiator traverses the topology by entering each expander and accessing each phy using the SMP DISCOVER function in an ascending order, from phy 0 to NUMBER OF PHYS. When the last phy in the current expander is encountered, the initiator enters the next expander encountered on the next sequential phy and begins the process again. The result is to group end devices by expander. The SAS addresses compiled are then organized without collapsing empty or duplicate phys.

Once the SAS addresses are compiled, the initiator shall update each of the expander devices or fanout expander devices within the topology that have configurable route tables. The initiator shall update the near edge expander device prior to exiting to configure the fanout expander device or any far edge expander devices.

Within each configurable edge expander device or configurable fanout expander device an organized route table shall exist that the initiator shall update to establish the topology route. To avoid issues with multiple initiators having to coordinate the update operation, the route table shall be updated identically, independent of which initiator performs the operation. Since the time to complete a discovery and configuration cycle is relatively small, there is no need to prevent an initiator from participating. The SMP CONFIGURE ROUTE INFORMATION function is used to configure the associated route tables.