To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 5 November 2005
Subject: 05-309r1 SAS-2 Add device name to IDENTIFY address frame

Revision history
Revision 0 (22 August 2005) First revision
Revision 1 (5 November 2005) Incorporated comments from September SAS protocol WG. Removed note suggesting how the initiator device name is allocated - that is a SAM entry.

Related documents
sas1r09e - Serial Attached SCSI revision 9e
05-144r9 - SAS-2 zoning (Tim Symons, Heng Liao, and Steve Gorshe, PMC-Sierra)

Overview
SAS-1.1 requires all SAS devices (both initiators and targets) to have device names. Target device name can be retrieved through the INQUIRY Device Identification VPD page 83h (an identifier with ASSOCIATION=2h). Initiator device names, however, are not available through any means defined in SAS.

This proposes adding the device name to the IDENTIFY address frame, so both initiator devices and target devices can report their names in a common manner.

The device name could be used by zoning (see 05-144) to grant permissions based on server or operating system instance (i.e. initiator device) identity rather than HBA physical port (i.e. initiator port) identity. If zoning only uses port identifiers and there is no access to initiator device names, HBA replacement becomes more difficult. With the initiator device name available, supervisor software can grant the new HBA port the same rights as the old if the initiator device name is still the same.

Additionally, the use of the phrase “SAS address” to define the 8-byte binary identifier format is confusing, since it’s not always used as an address (device names in particular are not used for addressing). This proposal renames that the “NAA IEEE Registered identifier format”.

Suggested changes

3.1.165 SAS address: A worldwide unique NAA IEEE Registered identifier ~~value~~ assigned to a SAS initiator port, SAS target port, or expander device~~, SAS initiator device, or SAS target device~~. See 4.2.2.

Editor’s Note 1: This definition now excludes initiator device names and target device names, since they’re irrelevant to the SAS transport, port, and link layers. In Figure 10 expander device class, change SAS address to device name and say that the expander ports inherit it as a SAS address? Or change SAS address everywhere to port identifier/device name?

4.1.1 Architecture overview

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Figure 1 shows the class diagram for a SAS domain, showing the relationships between SAS domain, SCSI domain, service delivery subsystem, expander device, expander port, SAS device, SCSI device, SAS port, SCSI port, and phy classes. Not all attributes are shown.

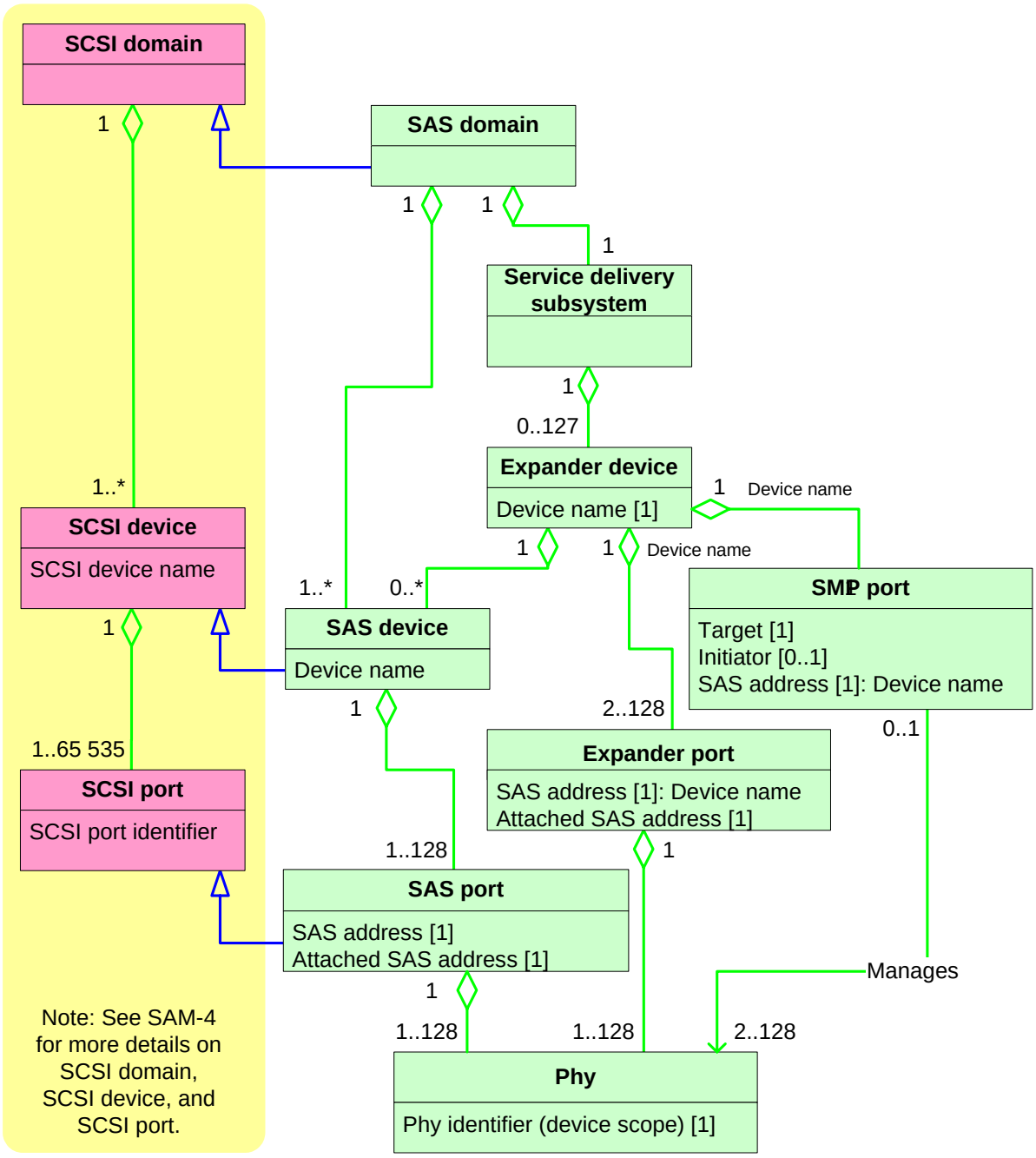

Figure 1 — SAS domain class diagram [modified]

Editor's Note 2: Figure needs work - how to show inherited attributes that change names?

4.1.2 Physical links and phys

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Each phy has:

a) a SAS address (see 4.2.2), inherited from the SAS port (see) or expander device;
b) a phy identifier (see 4.2.7) which is unique within the device;
c) optionally, support for being an SSP initiator phy;
d) optionally, support for being an STP initiator phy;
e) optionally, support for being an SMP initiator phy;
f) optionally, support for being an SSP target phy;
g) optionally, support for being an STP target phy; and
h) optionally, support for being an SMP target phy.

During the identification sequence (see 7.9), a phy:

a) transmits an IDENTIFY address frame including the device type (i.e., end device, edge expander device, or fanout expander device) of the device containing the phy, the SAS address of the SAS port or expander device containing the phy, the device name of the SAS device or expander device containing the phy, phy identifier, SSP initiator phy capability, STP initiator phy capability, SMP initiator phy capability, SSP target phy capability, STP target phy capability, and SMP target phy capability.
b) receives an IDENTIFY address frame containing the same set of information from the attached phy, including the attached device type, attached SAS address, attached device name, attached phy identifier, attached SSP initiator phy capability, attached STP initiator phy capability, attached SMP initiator phy capability, attached SSP target phy capability, attached STP target phy capability, and attached SMP target phy capability.

4.1.3 Ports (narrow ports and wide ports)

A port contains one or more phys. Ports in a device are associated with physical phys based on the identification sequence (see 7.9). Ports are associated with virtual phys based on the design of the device.

A port is created from one or more physical phys if, during the identification sequence (see 7.9), they:

a) transmitted the same SAS address (see 4.2) that the other physical phys in that port also transmitted in their outgoing IDENTIFY address frames (i.e., the SAS address is the same); and
b) received the same SAS address that the other physical phys in that port also received in their incoming IDENTIFY address frames (i.e., the attached SAS address is the same).

A port is a wide port if there are more than one phy in the port. A port is a narrow port if there is only one phy in the port.

A wide link is the set of physical links that attach a wide port to another wide port. A narrow link is the physical link that attaches a narrow port to another narrow port.

Attaching phys within a wide port to other phys in the same wide port (i.e., the SAS address transmitted in the outgoing IDENTIFY address frame is the same as the SAS address received in the incoming IDENTIFY address frame) is outside the scope of this standard.

Phys that are able to become part of the same wide port shall set the DEVICE TYPE field, SSP INITIATOR PORT bit, STP INITIATOR PORT bit, SMP INITIATOR PORT bit, SSP TARGET PORT bit, STP TARGET PORT bit, SMP TARGET PORT bit, and SAS ADDRESS field in the IDENTIFY address frame (see 7.8.2) transmitted during the identification sequence to the same set of values on each phy in the wide port. Recipient wide ports are not required to check the consistency of these fields across their phys.

4.2 Names and identifiers

4.2.1 Names and identifiers overview

Device names are worldwide unique names for devices within a transport protocol. Port names are worldwide unique names for ports within a transport protocol. Port identifiers are the values by which ports are identified within a domain. Phy identifiers are unique within a device.

Table 1 describes the definitions of names and identifiers for SAS.

Table 1 — Names and identifiers

Attribute	Format	SAS ~~implementation~~usage	Reference
Device name	NAA IEEE Registered format (see 4.2.2)	~~SAS address~~ Reported in the IDENTIFY address frame (see 7.8.2) and, for SSP target devices, in the Device Identification VPD page (see 10.2.11)	4.2.4
Port name	Not defined		4.2.5
Port identifier	NAA IEEE Registered format (see 4.2.2)	~~SAS address~~ Serves as the SAS address of the port (see 4.2.6)	4.2.6
Phy identifier	7-bit value (see 4.2.7)	Phy identifier	4.2.7

Table 2 describes how various SAM-3 attributes are implemented in SSP.

Table 2 — SAM-3 attribute mapping

SAM-3 attribute	SSP implementation
Initiator port identifier	SAS address of SSP initiator port
Initiator port name	Not defined
Target port identifier	SAS address of SSP target port
Target port name	Not defined
SCSI device name	~~SAS address of~~ SCSI device name

4.2.2 ~~SAS address~~NAA IEEE Registered identifier (SAS address) format

Table 3 defines the format used by device names and port identifiers ~~SAS address format~~. ~~SAS addresses~~Identifiers shall be compatible with the NAA (Name Address Authority) IEEE Registered format identification descriptor defined in SPC-3.

Table 3 — ~~SAS address~~ NAA IEEE Registered format

Byte\Bit	7	6	5	4	3	2	1	0
0	NAA (5h)				(MSB)			
1	IEEE COMPANY ID							
2								
3				(LSB)	~~(MSB)~~			
4	VENDOR-SPECIFIC IDENTIFIER							
5								
6								
7								~~(LSB)~~

Editor's Note 3: No need for MSB/LSB labels on a vendor-specific field.

The NAA field contains 5h.

The IEEE COMPANY ID field contains a 24-bit canonical form company identifier (i.e., organizationally unique identifier or OUI) assigned by the IEEE.

NOTE 1 - Information about IEEE company identifiers may be obtained from the IEEE Registration Authority web site at http://standards.ieee.org/regauth/oui.

The VENDOR-SPECIFIC IDENTIFIER field contains a 36-bit ~~numeric~~ value that is assigned by the organization associated with the company identifier in the IEEE COMPANY ID field. The VENDOR-SPECIFIC IDENTIFIER field shall be assigned so the ~~SAS address~~ NAA IEEE Registered identifier is worldwide unique.

A ~~SAS address~~ identifer value of of 00000000_00000000h indicates an invalid ~~SAS~~ identifier.

4.2.3 Hashed SAS address

SSP frames include ~~a~~ hashed versions of ~~the~~ SAS addresses (i.e., NAA IEEE Registered identifiers for SAS ports) to provide an additional level of verification of proper frame routing.

The code used for the hashing algorithm is a cyclic binary Bose, Chaudhuri, and Hocquenghem (BCH) (63, 39, 9) code. Table 4 lists the parameters for the code.

Table 4 — Hashed SAS address code parameter

Parameter	Value
Number of bits per codeword	63
Number of data bits	39
Number of redundant bits	24
Minimum distance of the code	9

The generator polynomial for this code is:

$$G(x) = (x^6 + x + 1)\ (x^6 + x^4 + x^2 + x + 1)\ (x^6 + x^5 + x^2 + x + 1)\ (x^6 + x^3 + 1)$$

After multiplication of the factors, the generator polynomial is:

$$G(x) = x^{24} + x^{23} + x^{22} + x^{20} + x^{19} + x^{17} + x^{16} + x^{13} + x^{10} + x^9 + x^8 + x^6 + x^5 + x^4 + x^2 + x + 1$$

Annex E contains information on SAS address hashing.

4.2.4 Device names

Each expander device, SAS initiator device, SAS target device, and SAS target/initiator device shall include an ~~SAS address~~ NAA IEEE Registered identifier (see 4.2.2) as its device name. An ~~SAS address~~ NAA IEEE Registered identifier used as a device name shall not be used as any other name or identifier (e.g., a device name, port name, port identifier, or logical unit name (see SAM-3)).

SAS devices and expander ~~Expander~~ devices report their device names in the IDENTIFY address frame (see 7.8.2).

Logical units accessed through SSP target ports report SAS target device names through SCSI vital product data (see 10.2.11).

~~NOTE 2 - There is no way to retrieve SAS initiator device names defined in this standard.~~

4.2.5 Port names

Port names are not defined in SAS.

NOTE 3 - The SAS addresses used by SAS ports in different SAS domains may be the same (e.g., when a set of phys transmit the same SAS address in the identification sequence but receive different SAS addresses, indicating they are attached to two separate SAS domains) so the SAS address serves as a port identifier (see 4.2.6) rather than a port name.

4.2.6 Port identifiers

Each SAS initiator port, SAS target port (e.g., including STP target ports in STP/SATA bridges), and SAS target/initiator port shall include an ~~SAS address~~ NAA IEEE Registered identifier (see 4.2.2) as its port identifier. An ~~SAS address~~ NAA IEEE Registered identifier used as a port identifier shall not be used as any other name or identifier (e.g., a device name, port name, or logical unit name (see SAM-3)) ~~but may be used as~~ except as a port identifier in one or more other SAS domains (see).

SAS ports in end devices report their port identifiers in the IDENTIFY address frame (see 7.8.2). Expander devices containing SAS ports (e.g., SAS ports attached to virtual phys, or STP target ports in STP/SATA bridges) report the port identifiers of those SAS ports in the SMP DISCOVER function (see 10.4.3.5).

Port identifiers are used as source and destination addresses in the OPEN address frame (see 7.8.3).

Logical units accessed through SSP target ports report SAS target port identifiers through SCSI vital product data (see 10.2.11).

4.2.7 Phy identifiers

Each SAS phy and expander phy shall be assigned an identifier that is unique within the SAS device and/or expander device. The phy identifier is used for management functions (see 10.4).

Phy identifiers shall be greater than or equal to 00h and less than 80h, and should be numbered starting with 00h. In an expander device or in a SAS device containing an SMP target port, phy identifiers shall be less than the value of the NUMBER OF PHYS field in the SMP REPORT GENERAL function (see 10.4.3.3). In a SAS device containing an SSP target port, phy identifiers shall be less than the value of the NUMBER OF PHYS field in the Protocol-Specific Port mode page for SAS SSP - Phy Control And Discover subpage (see 10.2.7.2.3).

7.8.2 IDENTIFY address frame

Table 5 defines the IDENTIFY address frame format used for the identification sequence. The IDENTIFY address frame is sent after the phy reset sequence completes if the physical link is a SAS physical link.

Table 5 — IDENTIFY address frame format

Byte\Bit	7	6	5	4	3	2	1	0
0	Restricted (for OPEN address frame)	DEVICE TYPE			ADDRESS FRAME TYPE (0h)			
1	Restricted (for OPEN address frame)							
2	Reserved				SSP INITIATOR PORT	STP INITIATOR PORT	SMP INITIATOR PORT	Restricted (for OPEN address frame)
3	Reserved				SSP TARGET PORT	STP TARGET PORT	SMP TARGET PORT	Restricted (for OPEN address frame)
4	~~Restricted (for OPEN address frame)~~ DEVICE NAME							
11								
12	SAS ADDRESS							
19								
20	PHY IDENTIFIER							
21	Reserved							
27								
28	(MSB) CRC							
31								(LSB)

The DEVICE TYPE field specifies the type of device containing the phy, and is defined in table 6.

Table 6 — DEVICE TYPE field

Code	Description
001b	End device
010b	Edge expander device
011b	Fanout expander device
All others	Reserved

The ADDRESS FRAME TYPE field shall be set to 0h.

An SSP INITIATOR PORT bit set to one specifies that an SSP initiator port is present. An SSP INITIATOR PORT bit set to zero specifies that an SSP initiator port is not present. Expander devices shall set the SSP INITIATOR PORT bit to zero.

An STP INITIATOR PORT bit set to one specifies that an STP initiator port is present. An STP INITIATOR PORT bit set to zero specifies that an STP initiator port is not present. Expander devices shall set the STP INITIATOR PORT bit to zero.

An SMP INITIATOR PORT bit set to one specifies that an SMP initiator port is present. An SMP INITIATOR PORT bit set to zero specifies that an SMP initiator port is not present. Expander devices may set the SMP INITIATOR PORT bit to one.

An SSP TARGET PORT bit set to one specifies that an SSP target port is present. An SSP TARGET PORT bit set to zero specifies that an SSP target port is not present. Expander devices shall set the SSP TARGET PORT bit to zero.

An STP TARGET PORT bit set to one specifies that an STP target port is present. An STP TARGET PORT bit set to zero specifies that an STP target port is not present. Expander devices shall set the STP TARGET PORT bit to zero.

An SMP TARGET PORT bit set to one specifies that an SMP target port is present. An SMP TARGET PORT bit set to zero specifies that an SMP target port is not present. Expander devices shall set the SMP TARGET PORT bit to one.

The DEVICE NAME field specifies the device name (see 4.2.4) of the SAS device or expander device transmitting the IDENTIFY address frame. A DEVICE NAME field set to 00000000 00000000h specifies the device name is not provided.

For SAS ports, the SAS ADDRESS field specifies the port identifier (see 4.2.6) of the SAS port transmitting the IDENTIFY address frame. For expander ports, the SAS ADDRESS field specifies the device name (see 4.2.4) of the expander device transmitting the IDENTIFY address frame.

NOTE 4 In expander devices, the DEVICE NAME field, if not set to 00000000 00000000h, contains the same value as the SAS ADDRESS field.

The PHY IDENTIFIER field specifies the phy identifier of the phy transmitting the IDENTIFY address frame.

See 4.1.3 for additional requirements concerning the DEVICE TYPE field, SSP INITIATOR PORT bit, STP INITIATOR PORT bit, SMP INITIATOR PORT bit, SSP TARGET PORT bit, STP TARGET PORT bit, SMP TARGET PORT bit, and SAS ADDRESS field.

The CRC field is defined in 7.8.1.

10.4.3.5 DISCOVER function

The DISCOVER function returns the physical link configuration information for the specified phy. This SMP function provides information from the IDENTIFY address frame received by the phy and additional phy-specific information. This SMP function shall be implemented by all SMP target ports.

Table 7 defines the request format.

Table 7 — DISCOVER request

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

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

The FUNCTION field shall be set to 10h.

The PHY IDENTIFIER field specifies the phy (see 4.2.7) for the link configuration information being requested.

The CRC field is defined in 10.4.3.1.

Table 8 defines the response format.

Table 8 — DISCOVER response (part 1 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (41h)							
1	FUNCTION (10h)							
2	FUNCTION RESULT							
3	RESPONSE LENGTH (56)							
4	Reserved							
8								
9	PHY IDENTIFIER							
10	Reserved							
11								
12	Reserved	ATTACHED DEVICE TYPE			Reserved			
13	Reserved				NEGOTIATED PHYSICAL LINK RATE			
14	Reserved				ATTACHED SSP INITIATOR	ATTACHED STP INITIATOR	ATTACHED SMP INITIATOR	ATTACHED SATA HOST

Table 8 — DISCOVER response (part 2 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
15	ATTACHED SATA PORT SELECTOR	Reserved			ATTACHED SSP TARGET	ATTACHED STP TARGET	ATTACHED SMP TARGET	ATTACHED SATA DEVICE
16	SAS ADDRESS							
23								
24	ATTACHED SAS ADDRESS							
31								
32	ATTACHED PHY IDENTIFIER							
33	Reserved							
39								
40	PROGRAMMED MINIMUM PHYSICAL LINK RATE				HARDWARE MINIMUM PHYSICAL LINK RATE			
41	PROGRAMMED MAXIMUM PHYSICAL LINK RATE				HARDWARE MAXIMUM PHYSICAL LINK RATE			
42	PHY CHANGE COUNT							
43	VIRTUAL PHY	Reserved			PARTIAL PATHWAY TIMEOUT VALUE			
44	Reserved				ROUTING ATTRIBUTE			
45	Reserved	CONNECTOR TYPE						
46	CONNECTOR ELEMENT INDEX							
47	CONNECTOR PHYSICAL LINK							
48	Reserved							
49								
50	Vendor specific							
51								
52	ATTACHED DEVICE NAME							
59								
~~52~~60	(MSB)	CRC						
~~55~~63								(LSB)

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

The FUNCTION field shall be set to 10h.

The FUNCTION RESULT field is defined in 10.4.3.2.

The RESPONSE LENGTH field contains the contains the number of dwords that follow, not including the CRC field. A RESPONSE LENGTH field set to 00h indicates there are 48 additional bytes in the response frame.

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The SAS ADDRESS field contains the value of the SAS ADDRESS field transmitted in the IDENTIFY address frame during the identification sequence. If the phy is an expander phy, the SAS ADDRESS field contains the SAS address of the expander device (see 4.2.4). If the phy is a SAS phy, the SAS ADDRESS field contains the SAS address of the SAS port (see 4.2.6).

The ATTACHED SAS ADDRESS field contains the value of the the SAS ADDRESS field received in the IDENTIFY address frame during the identification sequence. If the attached port is an expander port, the ATTACHED SAS

ADDRESS field contains the SAS address of the attached expander device (see 4.2.4). If the attached port is a SAS port, the ATTACHED SAS ADDRESS field contains SAS address of the attached SAS port (see 4.2.6). If the attached port is a SATA device port, the ATTACHED SAS ADDRESS field contains the SAS address of the STP/SATA bridge (see 4.6.2).

The ATTACHED SAS ADDRESS field shall be updated:

a) after the identification sequence completes, if a SAS phy or expander phy is attached; or
b) after the COMSAS Detect Timeout timer expires (see 6.8.3.9), if a SATA phy is attached.

An STP initiator port should not make a connection request to the attached SAS address until the ATTACHED DEVICE TYPE field is set to a value other than 000b.

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The CONNECTOR PHYSICAL LINK field indicates the physical link in the connector used to access the phy, as reported by the enclosure services process for the enclosure (see the SAS Connector element in SES-2).

The ATTACHED DEVICE NAME field contains the value of the the DEVICE NAME field received in the IDENTIFY address frame during the identification sequence. If the attached port is an expander port or a SAS port, the ATTACHED DEVICE NAME field contains the device name of the attached expander device or SAS device (see 4.2.4). If the attached port is a SATA device port, the ATTACHED DEVICE NAME field contains 00000000 00000000h.

The ATTACHED DEVICE NAME field shall be updated:

a) after the identification sequence completes, if a SAS phy or expander phy is attached; or
b) after the COMSAS Detect Timeout timer expires (see 6.8.3.9), if a SATA phy is attached.

The CRC field is defined in 10.4.3.2.