SM HBA API Overview

An overview of the draft
T11. SM HBA API for the T10
SAS WG

Rev 0
July 8, 2004
Agenda

• **HBA-API Background**
  - FC HBA API, SNIA and T11.5 History
  - Functional Overview

• **SM-HBA General Concepts & Status**
  - SM HBA Project and Scope
  - Relationship to T10 and SAS
  - SM-HBA Concepts & Functional Enhancements

• **Anticipated Elements of SM-HBA**
  - Proposed Generic Port Structures
  - Proposed Statistics Structures
  - SAS Expander Device Management Functions
HBA-API Background

- **SM-HBA is based on FC-HBA**
  - Fibre channel host-bus adapter management
- **SNIA developed Phase I of the FC-HBA-API specification.**
- **T11.5 developed Phase II of the FC-HBA Standard**
  - 1568-D forwarded to INCITS and BSR-9 forwarded to ANSI in April ‘04
  - [http://www.t11.org/index.htm](http://www.t11.org/index.htm) for additional details.

- Provides reporting of discovery and attributes of the HBA & domain
- Adopted by fibre channel management applications & HBA vendors
- Provides the basic support for SMI (Storage Management Initiative) FC-HBA Profile providers
HBA API Timeline
SNIA and T11.5

2000 2001 2002 2003 2004 2005

- SNIA FC HBA API (Phase I)
- T11/02-145v1 Proposal for FC HBA API
- SNIA FC HBA API (Phase II)
- T11/1568-D FC HBA API (Rev 14)
- T11/04-205v1 Approval for SM HBA API Project
- T11 FC MI Technical Report
- Current Proposal
FC HBA Functional Overview

- **FC HBA API Phase 1 supports:**
  - Local HBA and discovered FC Target Nx Ports
  - Reporting Nx Port statistics
  - Reporting of target Persistent Bindings
  - Several specific FC fabric management (FC-MI) Extended Link Service (ELS) requests including ELS CT Pass-thru

- **FC HBA API Phase 2 additions:**
  - Get and set persistent bindings
  - Set target persistent bindings
  - Asynchronous event callback
  - Target events registration (HBA, Port, Link)
  - FC4 statistics reporting
  - Single byte (SB) target device support
**FC HBA API Structure (UML)**

- **Local Nx Ports**
  - A physical port within the HBA

- **Discovered Nx Ports**
  - Nx Port targets discovered through a local Nx Port
  - FCP Port
    - A discovered target port that supports the FCP (SCSI) protocol
  - SB Port
    - A discovered target port that supports the SB (single byte) protocol

There is a 1 to * composite relationship between a Library and every class in this diagram.
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- Anticipated Elements of SM-HBA:
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  - Proposed Statistics Structure
  - SAS Expander Device Management Functions
SM HBA Project

- Next generation T11.5 Storage Management API
- T11.5 project #1695 approved by INCITS June ‘04
- SM-HBA WG:
  - Chair: George Penokie
  - Technical Editor: Krithivas Ramamurthy
  - Secretary: Vinod Bhat
  - T10 Liaison: Bob Sheffield
- Discovery and management of:
  - FC and SAS HBAs,
  - Elements of service delivery subsystem (fabric, expander devices),
  - FCP, SSP, SMP, STP and SATA target devices.
- Vendor independent management of storage devices
- SM-HBA proposal based on FC HBA API Phase 2:
  - ++ SAS HBA API specific data structures and functions
  - ++ Specific improvements for FC Management
**Scope SM HBA API**

SM HBA API is a standard API for the management of HBAs that support fibre channel and/or SAS protocols, and the use of fibre channel and SAS capabilities for discovery and management of the components of those protocol domains. The SM-HBA standard defines interfaces for the following capabilities:

<table>
<thead>
<tr>
<th>SM-HBA</th>
<th>Function</th>
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<tbody>
<tr>
<td>HBA &amp; End Ports</td>
<td>Monitoring &amp; control of descriptive &amp; operational characteristics</td>
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<tr>
<td></td>
<td>Statistics monitoring (Includes storage access traffic)</td>
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<td></td>
<td>Selective reporting of configuration, status and events (includes transport)</td>
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<tr>
<td>Transport</td>
<td>Monitoring &amp; control of descriptive &amp; operational characteristics</td>
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<tr>
<td>(service delivery</td>
<td>FC</td>
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<td>subsystem)</td>
<td>• Access to general fabric services (FC-GS-4)</td>
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<td>• Access to the extended link services (ELS) to comply with the manageability profile for HBAs</td>
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<td>recommended in FC-MI (see FC-MI)</td>
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<tr>
<td>Domain Resources</td>
<td>SAS</td>
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<tr>
<td></td>
<td>Access SAS management protocol (SMP) services for expander device management</td>
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<tr>
<td></td>
<td>Discovery and enumeration</td>
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<td></td>
<td>Monitoring &amp; control of availability &amp; representation</td>
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<tr>
<td>Domain Resources</td>
<td>FC</td>
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<td></td>
<td>SAS</td>
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<td></td>
<td>FCP-2, SB</td>
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<td>SSP, SMP, STP, &amp; SATA</td>
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## Interoperability

<table>
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<tr>
<th>App</th>
<th>FC-HBA Management Application</th>
<th>SM-HBA Management Application</th>
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<tbody>
<tr>
<td><strong>HW</strong></td>
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<tr>
<td>Fibre Channel HBA</td>
<td>• FC HBA API Library (1568-D)</td>
<td>• FC HBA API Library (1568-D)</td>
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<td></td>
<td>• SM-HBA API Library</td>
<td>• SM-HBA API Library</td>
</tr>
<tr>
<td>SAS HBA</td>
<td>[X]</td>
<td>• SM-HBA API Library</td>
</tr>
</tbody>
</table>
SM-HBA and SAS

- T11.5 defines storage/network management interfaces
  - non transport-specific (so may include SAS)
- SM-HBA draws upon SAS-1.1
  - Structure & Attributes
  - Domain-specific management requirements
- T10 SAS WG is encouraged to contribute to SM-HBA
- SM-HBA is a superset of FC-HBA that handles SAS
- SM-HBA may include IOCTL definitions for Driver I/F
- SM-HBA base = FC-HBA (1568-D)
  - All new elements added through proposals
SM-HBA Core Port Types

- **Local Port:**
  - Represents a physical SAS or FC port attached to the HBA

- **Discovered Port**
  - Represents a single target SAS or FC discovered on a Local Port.

- **FCP_Port:**
  - Discovered target device that supports the FCP (SCSI) protocol and associated bindings.
  - **Note:** How to distinguish Initiator and Target FCP_Ports?

- **SSP (Serial SCSI Protocol) Port:**
  - Discovered target device that supports the SAS (SCSI) protocol and associated bindings.

- **STP (Serial ATA Tunneling Protocol) Port:**
  - Discovered SATA target device that supports the STP protocol and associated bindings.

- **SMP (Serial Management Protocol) Port:**
  - Discovered SAS expander devices that supports the SMP Protocol.

- **SATA Port:**
  - Discovered SATA Devices. (Open. Not part of T11/04-205v1 Proposal)
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• Specifics: ✓
  – Proposed Generic Port Structure
  – Proposed Statistics Structure
  – SAS Expander Management Functions
SM-HBA
Data Structure Enhancements

Data Structures and Attributes:

- **PORTS**: Definition of a Generic HBA_PortAttributes (Section 6.4):
  - FC_Port (Nx_Port) attributes defined by 1568-D will not change.
  - Support/Addition of SAS Port attributes.
    - Definition of SAS PHY Attribute. *New*.

- **STATISTICS**: Definition of a Generic Port Statistics. (Section 6.5)
  - End Port (FC-0, FC-1 & FC-2) Statistics defined by 1568-D will not change.
    - Addition of SAS Port/Phy level Statistics. *New*
  - Statistics FC-4 may be made generic to include SSP, STP and SMP.

- **TARGET PORT**: Definition of Target_Port : (Section 6.6)
  - FCP_Port attributes defined by 1568-D may not change.
    - Persistent binding FCP Port enhancements (if any).
  - Addition of SSP, SMP, STP and SATA Bindings.
  - Possible HBA_BINDING structure definition.

- **EVENTS**: Polled Event and Asynchronous Event Notifications: (Section 6.9 & 6.10)
  - FC Link events and structures supported by 1568-D will not change.
  - Addition of SAS Specifics (e.g. Broadcast SES)
SM-HBA
Data Structure Enhancements

Data Structures and Attributes:

- **Basic Attribute Types & Status Return Types (Section 6.1 & 6.2):**
  - Additions (e.g. additional return status)

- **HBA Attribute (Section 6.3):**
  - HBA_Adapter_Attributes may not change. For, SAS NodeWWN is optional.

- **SB_Attributes, FC-3 Management Attributes and Library Attributes:**
  - No change (Section 6.7 & 6.8)

- **Library Attributes (Section 6.11):**
  - Additions (e.g. SAS Expander Management Functions)
Ports
(Generic HBA_PortAttributes)

- **Common Attributes**
  - PortWWN
  - PortSymbolicName[]
  - OSDeviceName[]
  - NumberofDiscoveredPorts
  - PortType

- **FC Specific**
  - NodeWWN
  - PortFciID
  - PortState
  - PortSupportedClassOfService
  - PortSupportedFC4Types
  - PortActiveFC4Types
  - PortSupportedSpeed
  - PortMaxFrameSize
  - FabricName

- **SAS Specific**
  - HBA_SASPortAttributes {
    
    HBA_SASPORTPROTOCOL
    HBA_SASPORTMODE
    HBA_UINT32
  }

  HBA_SASPORTATTRIBUTES,
  *PHBA_SASPORTATTRIBUTES;

- **Restructure into separate Common and Protocol-Specific Elements.**
- **Preserve Old Structures and Old Function Calls.**
- **Define New Structures and New Function Calls that return those data structures.**

- N_Port, NL_Port, F_Port, FL_Port, L_Port, PTP

- SAS Edge Expander, Fanout Expander, SAS End Device or Unknown
typedef struct HBA_SASPhyAttributes {

    HBA_SASPHYIDENTIFIER   PhyIdentifier;
    AttachedDeviceType;

    HBA_SASPHYSPEED         NegotiatedLinkRate;
    HBA_SASPHYSPEED         HardwareMinLinkRate;
    HBA_SASPHYSPEED         ProgrammedMinLinkRate;
    HBA_SASPHYSPEED         HardwareMaxLinkRate;
    HBA_SASPHYSPEED         ProgrammedMaxLinkRate;
    HBA_UINT32 PhyChangeCount;
    HBA_UINT32             MaximumFrameSize; Relevant?
    HBA_UINT32             MinimumFrameSize; Relevant?

} HBA_SASPHYATTRIBUTES,
*PHBA_SASPHYATTRIBUTES;

Phy structure based on the SMP Discover Response (Section 10.4.3.5)
Also consider 04-172r0: SAS-1.1 More counters
Statistics

- **Re-Definition of HBA_PortStatistics** to include support for FC0/FC1/FC2 and SAS Link level statistics.
- **Definition of HBA_ProtocolStatistics** (currently it is HBA_FC4Statistics) to support the following protocols:
  - FC4, SSP, STP and SMP.
  - Additional consideration would be to expand the scope of HBA_ProtocolStatistics to align with DMTF CR 1384 on Block level statistics.
Add SAS-specific Port and Phy statistics

**FC Statistics**
- SecondsSinceLastReset
- TxFrames
- TxWords
- RxFrames
- RxWords
- InvalidCRCCount

**SAS Statistics**
- SecondsSinceLastReset
- TxFrames
- TxWords
- RxFrames
- RxWords
- INVALID DWORD COUNT,
- RUNNING DISPARITY ERROR COUNT,
- LOSS OF DWORD SYNCHRONIZATION COUNT
- PHY RESET PROBLEM COUNT
  *(Work in Progress)*
Events
(SAS Specific)

• Similarities in Event management between SAS and FC. Existing mechanism suffices.
  – HBA_GetEventBuffer()
  – HBA_RegisterForAdapter[Add||Port|PortStat|]Events(),
  – HBA_RegisterFor[Target|Link]Events()
  – HBA_RemoveCallBack()

• Events Types are different. Implies that SAS Event Attributes need to be defined.
  – Broadcast SES
  – Broadcast CHANGE
  – Broadcast (Reserved #)

Add SAS-specific Event reporting
SM-HBA Functional Enhancements - I

HBA and Port Information Functions: (Section 7.3)

- **HBA_GetAdapterPortAttributes()**, **HBA_GetDiscoveredPortAttributes()** and **HBA_GetPortAttributesByWWN()** return proposed Generic Port structure.
  - **HBA_GetPhyAttributes:**
    - Returns SAS Phy Attributes for a specified Phy on a specific local or discovered SAS Port
    - Applicable to FC Ports?

  - **HBA_GetPhyStatistics()** returns the Generic Statistics Structure for SAS Ports

- **HBA_GetFC4Statistics()** may change to **HBA_GetProtocolStatistics()** for FC-FS & SSP/STP/SMP protocol mappings.
SM-HBA

Functional Enhancements - II

Fabric/Network/Link Management functions: (Section 7.8)

• FC Fabric (FC-MI and FC GS-4) in 1568-D: no change
• Addition of SAS Expanded Management Services:
  – Expander Generic:
    – Report General()
    – Report Manufacturer Information()
  – Specific Phy:
    – Discover()
    – Report Phy Error Log()
    – Report Phy Sata()
  – Route Table:
    – Report Route Information()
    – Configure Route Information()
  – Phy Control()
SM-HBA

Functional Enhancements - II

Fabric/Network/Link Management functions: (Section 7.8)

- **HBA_SendSMPReportGeneral**
  - Returns SMP Report General attributes for the specified expander

- **HBA_SendSMPReportManInfo**
  - Returns SMP Report Manufacturing Information for the specified expander

- **HBA_SendSMPDiscover**
  - Returns SMP Discover attributes for the specified expander

- **HBA_SendSMPPassThru**
  - Sends any SAS SMP Request to a SMP Target device Port specified by Port WWN and attached to a local SAS Port
  - Allows SAS expander configuration.
  - Not SCSI Pass through.
SM-HBA
Functional Enhancements - III

Target (FCP/SSP/STP/SATA) & SCSI Inquiry Information Functions: (Section 7.4 & 7.5)

- HBA_GetFCPTargetMappingV2() may evolve into HBA_GetTargetMappingV3 to include FCP, SSP and STP Targets.
- HBA_[Get/Set]FCPPersistentBindingV2() may evolve into HBA_[Get/Set]PersistentBindingV3() to include FCP, SSP and STP Targets.
- HBA_Remove[All]PersistentBinding will take in a HBA_BINDING structure as input (instead of HBA_FCPBINDING2)
- HBA_GetFCPStatistics() may evolve into HBA_GetProtocolStatisticsV3()
- SSP & FCP Targets continue to be identified through HBA_SCSIReportLuns(...) functions. Addition of STP and SATA Targets:
  - HBA_SendSTPIdentifyDevice()
    - Returns STP/SATA Identify Device attributes based on the local HBA Port WWN and STP Target device Port WWN
    - Supports identification of STP and direct attached SATA target devices.

May have a generic binding (FCP/SSP/STP) structure.