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NVM Express® Technical Proposal (TP)

Technical Proposal ID	TP4150 Clarifications to Namespace Changes Reporting
Revision Date	2024.06.07
Builds on Specification(s)	NVM Express Base Specification 2.0d NVM Command Set Specification 1.0d NVM Express Management Interface Specification 1.2d
References	TP4155 Independent Identify Namespace Data Structure Access TP6021 Status Reporting Enhancements TP4095a Namespace Capability Reporting TP4156a Reachability Architecture ECN116

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Technical Proposal Overview

This technical proposal adds clarifications related to change reporting for namespaces. Notifications for changes to attached namespaces use the existing AEN (now called Attached Namespace Attribute Changed), with the NSIDs of those changed namespaces being listed in the existing log page (now called Changed Attached Namespace List). Notifications for changes to attached namespaces and unattached namespaces use a new optional AEN defined by this TP (Allocated Namespace Attribute Changed), with the NSIDs of those changed namespaces being listed in a new log page defined by this TP (Changed Allocated Namespace List). Thus, this new AEN is a superset of the existing AEN which additionally includes notifications for changes to unattached namespaces.

Revision History

Revision Date	Change Description
2022.09.29	<ul style="list-style-type: none">Initial draft
2022.10.12	<ul style="list-style-type: none">Pulled in text from section 8.3.1 and section 8.11
2022.11.21	<ul style="list-style-type: none">Incorporated numerous changes and comments from internal HPE review
2022.12.13	<ul style="list-style-type: none">Namespace data structures listed in Identify Namespace data structures definition (section 1.5.29) are now listed in bulleted formCreated two new definitions that refer back to the Identify Namespace data structures definition: one for Active Identify Namespace data structures and one for Inactive Identify Namespace data structuresBackwards compatibility note in Namespace Attribute Changed switched from a “may” to a “might be reported...” for unattached namespaces
2023.01.19	<ul style="list-style-type: none">Clarified text in Changed Namespace List log page (LID 04h)Cleaned up wording in both new definitionsUpdated copyright year to 2023
2023.02.21	<ul style="list-style-type: none">Removed editorial changes to base spec Figure 273 (Identify – CNS Values) as TP4155 is already making those changes
2023.03.08	<ul style="list-style-type: none">Backwards compatibility note in Namespace Attribute Changed switched back from a “might” to a “may be reported...” for controllers compliant to previous specification versions reporting unattached namespace changesRemoved CNS 11h footnote 5 addition in NVM Command Set (will be done in an ECN)Removed CNS 1Bh table and subsection addition in NVM Command Set (will be done in an ECN)Modified new AEN (now called Allocated Namespace Attribute Changed), new log page (now called Changed Allocated Namespace List), and related text throughout the proposal to indicate that they report changes for both attached and unattached namespaces

2023.03.31	<ul style="list-style-type: none"> • Changed existing Namespace Attribute Changed AEN name to Attached Namespace Attribute Changed • Changed existing Changed Namespace List log page name to Changed Attached Namespace List • Changed existing Namespace Attribute Notices name to Attached Namespace Attribute Notices • Changed new Allocated Namespace Attribute Changed AEN name to Attached And Unattached Namespace Attribute Changed • Changed new Changed Allocated Namespace List log page name to Changed Attached And Unattached Namespace List • Changed new Allocated Namespace Attribute Notices name to Attached And Unattached Namespace Attribute Notices • Changed new Active Identify Namespace data structures definition name to Attached Identify Namespace data structures • Changed new Passive Identify Namespace data structures definition name to Unattached Identify Namespace data structures • Added Changed Attached And Unattached Namespace List log page to I/O / Admin / Discovery controller log page support tables • Added Changed Attached And Unattached Namespace List log page to Admin commands allowed during Format NVM/Sanitize command table for Get Log Page command • Added new support bit for Attached And Unattached Namespace Attribute Notices to OAES field in Identify Controller data structure • Added Attached And Unattached Namespace Attribute Changed AEN to conditions under Asymmetric Namespace Access Change AEN text • Added Attached And Unattached Namespace Attribute Changed AEN handling text to section 2.1.1 and Figure 77 in NVM Command Set spec • Added Attached And Unattached Namespace Attribute Changed to the following in NVMe-MI spec: <ul style="list-style-type: none"> ○ Health Status Change ○ Controller Health Status Poll ○ Controller Health Data Structure ○ Controller Health Status Changed Flags ○ NVM Subsystem Health Data Structure
2023.04.19	<ul style="list-style-type: none"> • Removed all NVMe-MI changes except CHDS and Get Log Page ones
2023.05.01	<ul style="list-style-type: none"> • Removed new Attached Identify Namespace data structures and Unattached Identify Namespace data structures definitions • Added new Allocated Namespace definition • Renamed new Attached and Unattached Namespace Attribute Changed AEN to Allocated Namespace Attribute Changed • Renamed new Attached and Unattached Namespace Attribute Notices AEN setting to Allocated Namespace Attribute Notices • Renamed new Changed Attached and Unattached Namespace List log page to Changed Allocated Namespace List • Added CNS 09h and CNS 0Ah to Identify Namespace data structures definition • Added Judy Brock as an author
2023.05.09	<ul style="list-style-type: none"> • Moved Allocated Namespace Attribute Notices controller support dependency from Asynchronous Event Configuration to OAES field in Identify Controller

2023.05.12	<ul style="list-style-type: none"> Changed reference in both log pages to point to Identify Namespace data structures definition instead of Figure 147 Reordered CNS values in Identify Namespace data structures definition to be in increasing numerical order Added reference to Identify Namespace data structures definition in both AENs and cleaned up wording Removed requirement that Namespace Management capability be supported in order for controllers to support new AEN Added name to new OAES bit (Allocated Namespace Attribute Notices) Renamed Bit 8 (Namespace Attribute Notices) in OAES field to Attached Namespace Attribute Notices Changed “may” to “should” for controller support of new AEN if Namespace Management capability is supported
2023.05.18	<ul style="list-style-type: none"> Changed new log page to controller scope Removed new log page from table of log pages allowed during Format NVM/Sanitize Removed “via the Namespace Management command” from both log pages when describing namespace create/delete actions
2023.06.22	<ul style="list-style-type: none"> Added reference to section 1.5.29 for an occurrence of “Identify Namespace data structures” in section 8.11 Made changes to section 8.3.1 based upon 6/22 TWG feedback
2023.06.29	<ul style="list-style-type: none"> Changed wording in section 8.3.1 to focus on “controller processing the command” instead of “controller associated with the host that issued the command” regarding a particular controller not sending an AEN when a namespace is deleted in an NVM Set Made changes in section 5.23: <ul style="list-style-type: none"> Made separate bullets for both AENs in attached case Changed “is” to “shall” for sending AEN when namespace deleted Added new sentence for unattached case Made separate bullets for both AENs in section 8.11 Pulled in text from TP4156 Reachability Architecture affected by this TP
2023.07.11	<ul style="list-style-type: none"> Made changes to section 5.23 based upon 7/6 TWG feedback
2023.07.13	<ul style="list-style-type: none"> Added “since the last time that this log page was read” to both log pages Made editorial changes to both log pages based upon 7/13 TWG feedback Made editorial changes to section 5.23 based upon 7/13 TWG feedback Added that the controller needs to have the AEN enabled to send it in section 8.3.1
2023.07.20	<ul style="list-style-type: none"> Made changes to both log pages based upon 7/20 TWG feedback Made changes to section 5.23 based upon 7/20 TWG feedback
2023.08.01	<ul style="list-style-type: none"> Added change descriptions for the TP
2023.08.24	<ul style="list-style-type: none"> Made changes to NAC bit text in CHDS Reworked host guidance text in section 8.11
2023.08.29	<ul style="list-style-type: none"> Made further changes to NAC bit text in CHDS based upon NVMe-MI workgroup feedback
2023.09.07	<ul style="list-style-type: none"> Changed example lead-in sentences in section 8.11 per TWG feedback Changed “host software” to “the host” in section 8.11 per TWG feedback Made miscellaneous edits to examples in section 8.11 per TWG feedback
2023.09.22	<ul style="list-style-type: none"> Changed delete operation text in section 8.11 and section 5.23 from “a controller processing the delete operation...” to “the controller processing the delete operation...” Changed every instance of “Namespace Attribute Changed notice(s)” and “Namespace Attribute Changed event(s)” to “Namespace Attribute Changed asynchronous event(s)” Added exception for controller processing the delete operation to “controller shall not send this event” list in both Attached Namespace Attribute Changed and Allocated Namespace Attribute Changed AENs Pointed the requirement text (shall statement) in Attached Namespace Attribute Changed AEN at the list of changes that cause the AEN to be sent. Added in a similar statement in Allocated Namespace Attribute Changed AEN Added “unless otherwise specified” into the requirement text in both AENs to account for the “controller shall not send” list

2023.09.27	<ul style="list-style-type: none"> Changed delete operation text in section 5.23 for additional clarity Clarified that the controller sending the Attached Namespace Attribute Changed AEN is attached to the namespace being deleted in section 5.23
2023.10.31	<ul style="list-style-type: none"> Changed “host software” to “a host” in both AENs Cleaned up some wording in Capacity Management delete NVM Set text and added prerequisite for the command being submitted in the Admin Submission Queue for excluded AEN reporting controller in section 8.3.1
2023.11.30	<ul style="list-style-type: none"> Clarified “controller to which the namespace is attached” and added two commas in section 5.23 for the Attached Namespace Attribute Changed AEN
2024.01.11	<ul style="list-style-type: none"> Broke out delete operation AEN requirement text into two bullet points for Admin Submission Queue vs. non-Admin Submission Queue, each with a sub bullet point per AEN type, and moved this text into its own subsection (section 5.23.1) Existing section 5.23.1 (Command Completion) renumbered to 5.23.2 Referenced new subsection 5.23.1 in places where delete operation AEN behavior is mentioned (section 8.3.1 and section 8.11) Updated year to 2024
2024.02.09	<ul style="list-style-type: none"> Changed delete operation AEN requirement text to include Capacity Management Relocated delete operation AEN requirement text into section 8.TBD Updated references to delete operation AEN requirement text to point to section 8.TBD Changed “controller shall not send” list in both AENs to include Capacity Management
2024.03.11	<ul style="list-style-type: none"> Added new paragraph to section 8.11 to indicate that other capabilities (like Capacity Management) are able to affect the number of namespaces existing within an NVM subsystem Moved namespace create/attach/detach/delete examples to new section 8.11.TBD1 Moved namespace deletion AEN requirement text to new section 8.11.TBD2 Changed references to section 8.11 as appropriate: <ul style="list-style-type: none"> 3.2.1.4 references 8.11.TBD1 5.3.1 references 8.11.TBD1 8.3.1 references 8.11.TBD1 and 8.11.TBD2
2024.03.12	<ul style="list-style-type: none"> Added references in section 5.23 pointing to section 8.11.TBD2 to indicate AEN requirements upon namespace deletion
2024.03.14	<ul style="list-style-type: none"> Added “that namespace was” clarification to section 8.3.1 per TWG feedback Added reference to section 8.3 for Capacity Management capability example in section 8.11 per TWG feedback Added highlighting to some section references as appropriate per TWG feedback Accepted all changes Closed all comments Replaced TBD placeholder with actual CNS value for I/O Command Set Independent Identify Namespace data structure for an Allocated Namespace ID and modified associated editor’s note in section 1.5.30 since TP4155 has since been ratified Updated TP4156 text to be based upon TP4156a Re-based upon 2.0d specs Version ready for integration
2024.05.14	<ul style="list-style-type: none"> Integrated
2024.06.05	<ul style="list-style-type: none"> Moved the Allocated Namespace Attribute Notices bit on the OAES field.
2024.06.07	<ul style="list-style-type: none"> Fixed broken links.

Description for Changes Document for NVM Express Base Specification 2.0d

New Features/Feature Enhancements/Required Changes:

- Allocated Namespace Attribute Changed (optional)
 - Description of changes:
 - Added all applicable CNS values to Identify Namespace data structures definition and added references where appropriate
 - Added definition for allocated namespace
 - Renamed Namespace Attribute Changed asynchronous event to Attached Namespace Attribute Changed
 - Renamed Changed Namespace List log page to Changed Attached Namespace List
 - Renamed Namespace Attribute Notices notice to Attached Namespace Attribute Notices
 - Defined Allocated Namespace Attribute Changed asynchronous event
 - Defined Changed Allocated Namespace List log page
 - Defined Allocated Namespace Attribute Notices notice
 - Defined Allocated Namespace Attribute Notices bit in OAES field of Identify Namespace data structure
 - Added clarifying text in Namespace Management command, Capacity Management capability, and Namespace Management capability sections regarding when Attached Namespace Attribute Changed and Allocated Namespace Attribute Changed asynchronous events are generated
 - **New requirement / incompatible change**
 - None
 - References
 - TP4150

Description for Changes Document for NVM Command Set Specification 1.0d

New Features/Feature Enhancements/Required Changes:

- Allocated Namespace Attribute Changed (optional)
 - Description of changes:
 - Renamed Namespace Attribute Changed asynchronous event to Attached Namespace Attribute Changed
 - Defined Allocated Namespace Attribute Changed asynchronous event (references NVM Express Base Specification)
 - **New requirement / incompatible change**
 - None
 - References
 - TP4150

Description for Changes Document for NVM Express Management Interface Specification 1.2d

New Features/Feature Enhancements/Required Changes:

- Allocated Namespace Attribute Changed (optional)
 - Description of changes:
 - Renamed Changed Namespace List log page to Changed Attached Namespace List
 - Added Changed Allocated Namespace List log page to Management Endpoint – Log Page Support figure
 - **New requirement / incompatible change**
 - Changed the Namespace Attribute Changed (NAC) bit in the Controller Health Data Structure (CHDS) to now be set when there are changes to either attached or unattached namespaces
 - References
 - TP4150

Markup Conventions:

Black:	Unchanged (however, hot links are removed)
Red Strikethrough:	Deleted
Blue:	New
Blue Highlighted:	TBD values, anchors, and links to be inserted in new text.
Purple:	Added by TP6021
Purple Strikethrough:	Deleted by TP6021
Light Blue Strikethrough:	Added by TP6021 and deleted by this TP
Brown:	Added by TP4156a
Brown Strikethrough:	Deleted by TP4156a
Dark Red Strikethrough:	Added by TP4156a and deleted by this TP
Orange:	Added by ECN116
Orange Strikethrough:	Deleted by ECN116
<Green Bracketed>:	Notes to editor
Olive:	Moved by this TP (destination)
Olive Strikethrough:	Moved by this TP (source)

Description of Specification Changes for NVM Express Base Specification 2.0d

1 Introduction

...

1.5 Definitions

...

1.5.30 Identify Namespace data structures

All namespace data structures that are able to be retrieved via the Identify command:

- Identify Namespace data structures (i.e., CNS 00h, CNS 09h, and CNS 11h);
- I/O Command Set Independent Identify Namespace data structures (i.e., CNS 08h and CNS 1Fh); and
- ~~each of the~~ I/O Command Set specific Identify Namespace data structures (i.e., CNS 05h, CNS 0Ah, and CNS 1Bh).

...

1.5.NEW1 allocated namespace

A namespace that is associated with an allocated NSID.

2 Theory of Operation

...

2.4 Extended Capabilities Theory

2.4.1 Multi-Path I/O and Namespace Sharing

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There is one or more Identify Controller data structures for each controller and one or more Identify Namespace data structures (refer to section 1.5.30) for each namespace (refer to Figure 274). Controllers with access to a shared namespace return the Identify Namespace data structure associated with that shared namespace (i.e., the same data structure contents are returned by all controllers with access to the same shared namespace). There is a globally unique identifier associated with the namespace itself and may be used to determine when there are multiple paths to the same shared namespace. Refer to section 4.5.1.

...

3 NVM Express Architecture

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3.1 NVM Controller Architecture

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3.1.2 Controller Types

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3.1.2.1 I/O Controller

...

3.1.2.1.2 Log Page Support

...

Figure 24: I/O Controller – Log Page Support

Log Page Name	Log Page Support Requirements ¹
Supported Log Pages	M ³
Error Information	M
...	...
Changed Attached Namespace List	O
...	...
Changed Allocated Namespace List	O
Notes: 1. O/M/P definition: O = Optional, M = Mandatory, P = Prohibited 2. Mandatory for controllers that support Fixed Capacity Management (refer to section 8.3.2). 3. Optional for NVM Express revision 1.4 and earlier. 4. Optional if the NVMe-MI Send command and the NVMe-MI Receive command are not supported (refer to Figure 22).	

...

3.1.2.2 Administrative Controller

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3.1.2.2.2 Log Page Support

...

Figure 29: Administrative Controller – Log Page Support

Log Page Name	Command Support Requirements ¹
Supported Log Pages	M ⁴
Error Information	M
...	...
Changed Attached Namespace List	O
...	...
Changed Allocated Namespace List	O
Notes: 1. O/M/P definition: O = Optional, M = Mandatory, P = Prohibited 2. Optional if Set Features command is not supported (refer to Figure 28). 3. Optional if NVMe-MI Send command and NVMe-MI Receive command is not supported (refer to Figure 28). 4. Optional for NVM Express revision 1.4 and earlier.	

...

3.1.2.3 Discovery Controller

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3.1.2.3.3 Log Page Support

...

Figure 33: Discovery Controller – Log Page Support

Log Page Name	Command Support Requirements ¹
Supported Log Pages	M ³
Error Information	O
...	...
Changed Attached Namespace List	P

Figure 33: Discovery Controller – Log Page Support

Log Page Name	Command Support Requirements ¹
...	...
Changed Allocated Namespace List	P
Notes	
1. O/M/P definition: O = Optional, M = Mandatory, P = Prohibited	
2. Optional if Set Features command is not supported (refer to Figure 32).	
3. Optional for versions 1.1 and earlier of the NVMe over Fabrics specification.	

...

3.2 NVM Subsystem Entities

...

3.2.1 Namespaces

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3.2.1.4 Active and Inactive NSID Types

For a specific controller, an allocated NSID is:

- a) an active NSID; or
- b) an inactive NSID.

Active NSIDs for a controller refer to namespaces that are attached to that controller. Allocated NSIDs that are inactive for a controller refer to namespaces that are not attached to that controller.

Unallocated NSIDs are inactive NSIDs for all controllers in the NVM subsystem.

An allocated NSID may be an active NSID for some controllers and an inactive NSID for other controllers in the same NVM subsystem if the namespace that the NSID refers to is attached to some controllers, but not all controllers, in the NVM subsystem.

Refer to section ~~8.11~~ 8.11.TBD1 for actions associated with a namespace being detached or deleted.

...

5 Admin Command Set

...

Figure 141: Sanitize Operations and Format NVM Command – Admin Commands Allowed

Admin Command	Additional Restrictions for Format NVM command	Additional Restrictions for sanitize operations
Abort		
Asynchronous Event Request		
...

Figure 141: Sanitize Operations and Format NVM Command – Admin Commands Allowed

Admin Command	Additional Restrictions for Format NVM command	Additional Restrictions for sanitize operations
Get Log Page	The log pages allowed for both Format NVM command and sanitize operations are listed below.	
	Log Pages	Additional Restrictions for both Format NVM command and sanitize operations
	Error Information	Return 0h in the LBA field.
	SMART / Health Information	
	Changed Attached Namespace List	
	Reservation Notification	
	Asymmetric Namespace Access	
	Sanitize Status	
	Vendor specific	Prohibited for Sanitize
	Persistent Event Log	Prohibited for Sanitize
	Boot Partition	
...
Opcode 7Fh	The Fabric Commands allowed are listed below. Refer to section 6.	
	Fabrics Commands	Additional Restrictions for both Format NVM command and sanitize operations
	Property Set	
	Connect	
	Disconnect	
	Property Get	
	Authentication Send	
	Authentication Receive	
	Vendor Specific	Commands are allowed that do not affect or retrieve user data.
Vendor Specific	Commands are allowed that do not affect or retrieve user data.	

...

5.2 Asynchronous Event Request command

...

5.2.1 Command Completion

...

Figure 148: Asynchronous Event Information – Notice

Value	Description
00h	<p>Attached Namespace Attribute Changed: Indicates a change to one or more of the following:</p> <ul style="list-style-type: none"> the Identify Namespace data structures (refer to section 1.5.30) that are associated with an attached namespace (refer to the applicable NVMe I/O Command Set specification) for one or more namespaces; the I/O Command Set Independent Identify Namespace data structure; the Active Namespace ID List (i.e., CNS 02h) returned when the Identify command is issued with the CNS field set to 02h; or the I/O Command Set specific Active Namespace ID list (i.e., CNS 07h); or other data structures as specified in applicable NVMe I/O Command Set specifications. <p>This event shall be reported for any of the changes in the preceding list to namespaces that are attached to the controller, unless otherwise specified. This event may be reported by controllers compliant to previous versions of this specification for changes to namespaces that are not attached to the controller.</p> <p>To clear this event, a host software issues a Get Log Page command for the Changed Attached Namespace List log page (refer to section 5.16.1.5) with the Retain Asynchronous Event bit cleared to '0'.</p> <p>A controller shall not send this event if:</p> <ol style="list-style-type: none"> Namespace Status (refer to Figure 281) has changed and shutdown processing is either occurring (i.e., CSTS.SHST is set to 01b) or complete (i.e., CSTS.SHST is set to 10b); that controller receives a command (e.g., a Namespace Management command or Capacity Management command) on the Admin Submission Queue (e.g., not via a Management Endpoint, refer to the NVM Express Management Interface Specification) that requests a delete operation for a namespace; the ANAGRPID field (refer to Figure 281) has changed; or the RGRPID field (refer to Figure 281) has changed; or an I/O Command Set specific change occurs (refer to the applicable I/O Command Set specification). <p>A controller shall only send this event for changes to the Format Progress Indicator field when bits 6:0 of that field transition from a non-zero value to 0h, or from 0h to a non-zero value.</p>
01h	<p>Firmware Activation Starting: The controller is starting a firmware activation process during which command processing is paused. The host may use CSTS.PP to determine when command processing has resumed. To clear this event, the host reads the Firmware Slot Information log page with the Retain Asynchronous Event bit cleared to '0'.</p>
...	...
03h	<p>Asymmetric Namespace Access Change: The Asymmetric Namespace Access information (refer to section 5.16.1.13) related to an ANA Group that contains namespaces attached to this controller has changed (e.g., an ANA state has changed, an ANAGRPID has changed). The current Asymmetric Namespace Access information for attached namespaces is indicated in the Asymmetric Namespace Access log page (refer to section 5.16.1.13). To clear this event, the host issues a Get Log Page command (refer to section 5.16) with the Retain Asynchronous Event bit cleared to '0' for the Asymmetric Namespace Access log.</p> <p>A controller shall not send this event if an Attached Namespace Attribute Changed asynchronous event or an Allocated Namespace Attribute Changed asynchronous event is sent for the same event, such as a change due to:</p> <ol style="list-style-type: none"> the attachment of a namespace (refer to section 5.22); the deletion of a namespace (refer to section 5.23); or the detachment of a namespace (refer to section 5.22).
...	...

Figure 148: Asynchronous Event Information – Notice

Value	Description
07h	<p>Reachability Group Change: The Reachability Group information (refer to section 5.16.1.TBD-1) related to a Reachability Group that contains namespaces attached to this controller has changed (e.g., a member was added to or deleted from a Reachability Group). The current Reachability Group information for attached namespaces is indicated in the Reachability Groups log page. To clear this event, the host issues a Get Log Page command (refer to section 5.16) with the Retain Asynchronous Event bit cleared to '0' for the Reachability Groups log page.</p> <p>A controller shall not send this event if an Attached Namespace Attribute Changed asynchronous event notice or an Allocated Namespace Attribute Changed asynchronous event is sent for the same event, such as a change due to:</p> <ul style="list-style-type: none"> a) the attachment of a namespace (refer to section 5.22); b) the deletion of a namespace (refer to section 5.23); or c) the detachment of a namespace (refer to section 5.22).
08h	<p>Reachability Association Change: The Reachability Association information (refer to section 5.16.1.TBD-2) related to a Reachability Association that contains namespaces attached to this controller has changed (e.g., a member was added to or deleted from a Reachability Association). The current Reachability Association information for attached namespaces is indicated in the Reachability Associations log page. To clear this event, the host issues a Get Log Page command (refer to section 5.16) with the Retain Asynchronous Event bit cleared to '0' for the Reachability Associations log page.</p> <p>A controller shall not send this event if an Attached Namespace Attribute Changed asynchronous event notice or an Allocated Namespace Attribute Changed asynchronous event is sent for the same event, such as a change due to:</p> <ul style="list-style-type: none"> a) the attachment of a namespace (refer to section 5.22); b) the deletion of a namespace (refer to section 5.23); or c) the detachment of a namespace (refer to section 5.22).

Figure 148: Asynchronous Event Information – Notice

Value	Description
09h	<p>Allocated Namespace Attribute Changed: Indicates a change to one or more of the following:</p> <ul style="list-style-type: none"> Identify Namespace data structures (refer to section 1.5.30) that are associated with an allocated namespace (refer to section 1.5.NEW1); the Active Namespace ID list (i.e., CNS 02h); the I/O Command Set specific Active Namespace ID list (i.e., CNS 07h); the Allocated Namespace ID list (i.e., CNS 10h); the I/O Command Set specific Allocated Namespace ID list (i.e., CNS 1Ah); or other data structures as specified in the applicable NVMe I/O Command Set specifications. <p>This event shall be reported for any of the changes in the preceding list to namespaces that are either attached to the controller or not attached to the controller, unless otherwise specified.</p> <p>To clear this event, a host issues a Get Log Page command for the Changed Allocated Namespace List log page (refer to section 5.16.1.NEW) with the Retain Asynchronous Event bit cleared to '0'.</p> <p>A controller shall not send this event if:</p> <ol style="list-style-type: none"> Namespace Status (refer to Figure 281) has changed and shutdown processing is either occurring (i.e., CSTS.SHST is set to 01b) or complete (i.e., CSTS.SHST is set to 10b); that controller receives a command (e.g., a Namespace Management command or Capacity Management command) on the Admin Submission Queue (e.g., not via a Management Endpoint, refer to the NVM Express Management Interface Specification) that requests a delete operation for a namespace; the ANAGRPID field (refer to Figure 281) has changed; the RGRPID field (refer to Figure 2810) has changed; or an I/O Command Set specific change occurs (refer to the applicable I/O Command Set specification). <p>A controller shall only send this event for changes to the Format Progress Indicator field when bits 6:0 of that field transition from a non-zero value to 0h, or from 0h to a non-zero value.</p>
07h 0Ah to EEh	Reserved
EFh ²	Zone Descriptor Changed: I/O Command Set specific definition.
F0h	Discovery Log Page Change: A change has occurred to one or more of the Discovery Log Pages. To clear this event, the host or Discovery controller reads the Discovery log page with the Retain Asynchronous Event bit cleared to '0'.
F1h to FFh	Reserved for future NVMe over Fabrics Asynchronous Event Notifications
<p>NOTE:</p> <ol style="list-style-type: none"> Refer to the NVM Command Set specification. Refer to the Zoned Namespace Command Set specification. 	

...

5.3 Capacity Management command

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5.3.1 Media Unit Configuration Selection

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If the Operation field specifies the Select Capacity Configuration operation and the Element Identifier field is cleared to '0', then the controller shall clear the configuration by performing all of the following actions in

sequence:

- 1) Delete all namespaces in the domain that contains the controller processing the command, as described in section ~~8.11~~ 8.11.TBD1.
- 2) Delete all NVM Sets in the domain that contains the controller processing the command, if any.
- 3) Delete all Endurance Groups in the domain that contains the controller processing the command.
- 4) Clear the Selected Configuration field to 0h in the Media Unit Status log page.

...

5.14 Format NVM command

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After successful completion of a Format NVM command, the settings specified in the Format NVM command (e.g., PI, MSET, LBAF) are reported as part of the Identify Namespace data structures (refer to section 1.5.30).

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5.16 Get Log Page command

...

5.16.1 Log Specific Information

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Figure 203: Get Log Page – Log Page Identifiers

Log Page Identifier	CSI ⁷	Scope	Log Page Name	Reference Section
00h	Y	Controller	Supported Log Pages	5.16.1.1
01h	N	Controller	Error Information	5.16.1.2
...
04h	N	Controller	Changed Attached Namespace List	5.16.1.5
...
1Ch	N	Controller	Changed Allocated Namespace List	5.16.1.NEW
47h 1Dh to 6Fh	Reserved			
70h	N	Controller	Discovery	5.16.1.23
71h to 7Fh	Reserved			
80h	N	Controller	Reservation Notification	5.16.1.24
81h	N	NVM subsystem	Sanitize Status	5.16.1.25
82h to BEh	I/O Command Set Specific			
BFh	Refer to the Zoned Namespace Command Set			
C0h to FFh	Vendor specific ⁵			
Key: Namespace = The log page contains information about a specific namespace. Endurance Group = The log page contains information about a specific Endurance Group. Controller = The log page contains information about the controller that is processing the command. Domain = The log page contains information about the Domain. NVM subsystem = The log page contains information about the NVM subsystem. Vendor Specific = The log page contains information that is vendor specific.				

...

5.16.1.5 Changed Attached Namespace List (Log Identifier 04h)

This log page is used to describe changes to attached namespaces for this ~~attached to the~~ controller, since the last time that this log page was read, that ~~have~~:

- a) have changed information in their Identify Namespace data structures (refer to ~~in Figure 148~~ section 1.5.30) ~~since the last time the log page was read;~~
- ~~b) changed information in their I/O Command Set Independent Identify Namespace data structure since the last time the log page was read;~~
- b) ~~been added~~ were previously unattached to the controller and have since been attached to the controller; ~~and~~
- c) ~~been deleted~~ were previously attached to the controller and have since been detached from the controller; ~~and~~
- d) were deleted.

The log page contains a Namespace List with up to 1,024 entries. If more than 1,024 namespaces have changed attributes since the last time the log page was read, the first entry in the log page shall be set to FFFFFFFFh and the remainder of the list shall be zero filled.

5.16.1.NEW Changed Allocated Namespace List (Log Identifier 1Ch)

This log page is used to describe changes to allocated namespaces (refer to section 1.5.NEW1), since the last time that this log page was read, that:

- a) have changed information in their Identify Namespace data structures (refer to section 1.5.30);
- b) were previously unattached to the controller and have since been attached to the controller;
- c) were previously attached to the controller and have since been unattached from the controller;
- d) were created; and
- e) were deleted.

The log page contains a Namespace List with up to 1,024 entries. If more than 1,024 namespaces have changed attributes since the last time the log page was read, the first entry in the log page shall be set to FFFFFFFFh and the remainder of the list shall be zero filled.

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5.17 Identify command

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5.17.2 Identify Data Structures

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5.17.2.1 Identify Controller Data Structure (CNS 01h)

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Figure 276: Identify – Identify Controller Data Structure, I/O Command Set Independent

Bytes	I/O ¹	Admin ¹	Disc ¹	Description
Controller Capabilities and Features				
...
91:88	M	M	R	RTD3 Entry Latency (RTD3E): This field indicates the typical latency in microseconds to enter Runtime D3 (RTD3). Refer to section 8.15.4. A value of 0h indicates RTD3 Entry Latency is not reported.

Figure 276: Identify – Identify Controller Data Structure, I/O Command Set Independent

Bytes	I/O ¹	Admin ¹	Disc ¹	Description
95:92	M	M	M	<p>Optional Asynchronous Events Supported (OAES): This field indicates the optional asynchronous events supported by the controller. A controller shall not send optional asynchronous events before they are enabled by host software.</p> <p>Bit 31 is set to '1' if the controller supports sending Discovery Log Page Change Notifications. If cleared to '0', then the controller does not support the Discovery Log Page Change Notification events.</p> <p>Bits 30:28 are reserved.</p> <p>Bit 27 is set to '1' if the controller supports the Zone Descriptor Changed Notices event and the associated Changed Zone List log page (refer to the Zoned Namespace Command Set Specification). If cleared to '0', then the controller does not support the Zone Descriptor Changed Notices event nor the associated Changed Zone List log page.</p> <p>Bits 26:20 are reserved.</p> <p>Bit 19 Allocated Namespace Attribute Notices: If this bit is set to '1', then the controller supports the Allocated Namespace Attribute Notices event and the associated Changed Allocated Namespace List log page. If this bit is cleared to '0', then the controller does not support the Allocated Namespace Attribute Notices event nor the associated Changed Allocated Namespace List log page.</p> <p>Bits 18:16 are reserved.</p> <p>Bit 15 is set to '1' if the controller supports the Normal NVM Subsystem Shutdown event. If cleared to '0', then the controller does not support the Normal NVM Subsystem Shutdown event.</p> <p>Bit 14 is set to '1' if the controller supports the Endurance Group Event Aggregate Log Page Change Notices event. If cleared to '0', then the controller does not support the Endurance Group Event Aggregate Log Page Change Notices event.</p> <p>Bit 13 is set to '1' if the controller supports the LBA Status Information Alert Notices event (refer to the NVM Command Set Specification). If cleared to '0', then the controller does not support the LBA Status Information Alert Notices event.</p> <p>Bit 12 is set to '1' if the controller supports the Predictable Latency Event Aggregate Log Change Notices event. If cleared to '0', then the controller does not support the Predictable Latency Event Aggregate Log Change Notices event.</p> <p>Bit 11 is set to '1' if the controller supports sending Asymmetric Namespace Access Change Notices. If cleared to '0', then the controller does not support the Asymmetric Namespace Access Change Notices event.</p> <p>Bit 10 is reserved.</p> <p>Bit 9 is set to '1' if the controller supports the Firmware Activation Notices event. If cleared to '0', then the controller does not support the Firmware Activation Notices event.</p> <p>Bit 8 Attached Namespace Attribute Notices: If set to '1' if the controller supports the Attached Namespace Attribute Notices event and the associated Changed Attached Namespace List log page. If cleared to '0', then the controller does not support the Attached Namespace Attribute Notices event nor the associated Changed Attached Namespace List log page.</p> <p>Bits 7:0 are reserved.</p>
...

...

5.23 Namespace Management command

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The ~~h~~Host software uses the Namespace Attachment command to attach or detach a namespace to or from a controller. The create operation does not attach the namespace to a controller. As a side effect of the delete operation, the namespace is detached from all controllers as the namespace is no longer present in the system. It is recommended that host software detach all controllers from a namespace prior to deleting the namespace. ~~If the namespace is not detached from all controllers prior to being deleted, then Attached Namespace Attribute Changed asynchronous events are reported as specified in section 8.11.TBD2. If a namespace is deleted, then Allocated Namespace Attribute Changed asynchronous events are reported as specified in section 8.11.TBD2. If the namespace is attached to another controller (i.e., a controller other than the controller processing the operation) and that controller has Namespace Attribute Notices enabled (refer to Figure 327), when a delete operation is requested, then as part of the delete operation a Namespace Attribute Notice is issued by that controller to indicate a namespace change.~~

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5.27 Set Features command

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5.27.1 Feature Specific Information

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5.27.1.8 Asynchronous Event Configuration (Feature Identifier 0Bh)

...

Figure 327: Asynchronous Event Configuration – Command Dword 11

Bits	Description
31	Discovery Log Page Change Notification: This bit indicates that the Discovery controller reports Discovery Log Page Change Notifications. If set to '1', the Discovery controller shall send a notification if Discovery Log Page changes occur.
30:28	Reserved
27	Zone Descriptor Changed Notices²: I/O Command Set specific definition.
26:16 20	Reserved
19	Allocated Namespace Attribute Notices: This bit determines whether an asynchronous event notification is sent to the host for an Allocated Namespace Attribute Changed asynchronous event (refer to Figure 148). If this bit is set to '1', then the Allocated Namespace Attribute Changed asynchronous event is sent to the host when this condition occurs. If this bit is cleared to '0', then the controller shall not send the Allocated Namespace Attribute Changed asynchronous event to the host.
...	...
08	Attached Namespace Attribute Notices: This bit determines whether an asynchronous event notification is sent to the host for an Attached Namespace Attribute e Changed asynchronous event (refer to Figure 148). If this bit is set to '1', then the Attached Namespace Attribute Changed asynchronous event is sent to the host when this condition occurs. If this bit is cleared to '0', then the controller shall not send the Attached Namespace Attribute Changed asynchronous event to the host.
07:00	SMART / Health Critical Warnings: This field determines whether an asynchronous event notification is sent to the host for the corresponding Critical Warning specified in the SMART / Health Information log (refer to Figure 208). If a bit is set to '1', then an asynchronous event notification is sent when the corresponding critical warning bit is set to '1' in the SMART / Health Information log. If a bit is cleared to '0', then an asynchronous event notification is not sent when the corresponding critical warning bit is set to '1' in the SMART / Health Information log.
NOTE: 1. Refer to the NVM Command Set specification. 2. Refer to the Zoned Namespace Command Set specification.	

8 Extended Capabilities

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8.3 Capacity Management

8.3.1 Overview

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If an NVM Set is deleted, then ~~the controller performs~~ the following actions **are performed** in sequence:

- 1) the NVM Set Identifier is removed from the NVM Set List;
 - 2) if the Media Unit Status log page is supported, then the NVM Set Identifier field is cleared to 0h in all Media Unit Status Descriptors, if any, that indicated the deleted NVM Set;
 - 3) for each namespace in the deleted NVM Set:
 - a. all commands targeting the namespace are handled as described for namespace deletion in section **8.11.TBD1**;
 - b. the namespace identifier is removed from the Allocated Namespace ID list;
 - c. the namespace is deleted;
 - d. **for each controller to which the namespace was attached when that namespace was deleted:**
 - i. the namespace identifier is added to the Changed **Attached** Namespace List log page for that controller; and
 - ii. an **Attached** Namespace Attribute Changed **asynchronous** event is generated by that controller as described in section **8.11.TBD2**~~for hosts other than the host which issued the Capacity Management command;~~
 - e. the namespace identifier is added to the Changed Allocated Namespace List log page for each controller in the NVM subsystem; and
 - f. an **Allocated** Namespace Attribute Changed **asynchronous** event is generated for each controller that has **Allocated** Namespace Attribute Notices enabled as described in section **8.11.TBD2**;
- and
- 4) the Unallocated Endurance Group Capacity indicated by the Endurance Group Information log page is increased by the amount of capacity formerly allocated to the NVM Set.

...

8.11 Namespace Management

The Namespace Management capability consists of the Namespace Management command (refer to section 5.23) and the Namespace Attachment command (refer to section 5.22). The Namespace Management command is used to create a namespace or delete a namespace. The Namespace Attachment command is used to attach and detach controllers from a namespace. The Namespace Management capability is intended for use during manufacturing or by a system administrator.

In addition to the Namespace Management capability, there are other events and capabilities that are able to affect the number of namespaces that exist within an NVM subsystem (e.g., the Capacity Management capability as described in section **8.3).**

If the Namespace Management capability is supported, then the controller:

- a) shall support the Namespace Management command and the Namespace Attachment command;
- b) shall set bit 3 to '1' in the OACS field (refer to Figure 276);
- c) should support the **Attached** Namespace Attribute Changed asynchronous event (refer to Figure 148 and section 5.27.1.8);~~and~~
- d) **should support the Allocated Namespace Attribute Changed asynchronous event (refer to Figure 148 and section 5.27.1.8); and**
- e) may support Namespace Granularity (refer to the NVM Command Set Specification).

8.11.TBD1 Namespace Management Examples

The following is an example of how a host ~~To~~-creates a namespace, ~~host software performs the following actions:~~

1. the ~~H~~host-~~software~~ requests the Identify Namespace data structure that specifies common namespace capabilities (i.e., using an Identify command with the NSID field set to FFFFFFFFh and the CNS field cleared to 0h);
2. ~~If~~ the controller supports reporting of I/O Command Set specific Namespace Management content (refer to the Namespace Management section in the applicable I/O Command Set specification), the host-~~software~~ optionally requests that information (e.g. Namespace Granularity);
3. the ~~H~~host-~~software~~ determines available capacity (refer to section 3.8);
4. the ~~H~~host-~~software~~ creates the data structure defined in Figure 301 (e.g., taking into account the common namespace capabilities, available capacity);
5. the ~~H~~host-~~software~~ issues the Namespace Management command specifying the Create operation and the data structure. On successful completion of the command, the Namespace Identifier of the new namespace is returned in Dword 0 of the completion queue entry. At this point, the new namespace is not attached to any controller; and
6. if Allocated Namespace Attribute Notices are enabled on the controller, then the ~~H~~host-~~software~~ requests the Identify Namespace data structures (refer to section 1.5.30) for the new namespace to determine all attributes of the namespace upon receiving an Allocated Namespace Attribute Changed asynchronous event from that controller.

The following is an example of how a host ~~To~~-attaches a namespace, ~~host software performs the following actions:~~

1. the ~~H~~host-~~software~~ issues the Namespace Attachment command specifying the Controller Attach operation to attach the specified namespace to one or more controllers; ~~and~~
2. the host receives an Attached Namespace Attribute Changed asynchronous event from each controller that has a namespace newly attached to that controller ~~If~~ Attached Namespace Attribute Notices are enabled on that controller, ~~the controller(s) newly attached to the namespace report a Namespace Attribute Changed asynchronous event to the host.; and~~
3. the host receives an Allocated Namespace Attribute Changed asynchronous event from each controller that has Allocated Namespace Attribute Notices enabled.

The following is an example of how a host ~~To~~-detaches a namespace, ~~host software performs the following actions:~~

1. the ~~H~~host-~~software~~ issues the Namespace Attachment command specifying the Controller Detach operation to detach the specified namespace from one or more controllers; ~~and~~
2. the host receives an Attached Namespace Attribute Changed asynchronous event from each controller that has a namespace newly detached from that controller ~~If~~ Attached Namespace Attribute Notices are enabled on that controller, ~~the controllers that were detached from the namespace report a Namespace Attribute Changed asynchronous event to the host.; and~~
3. the host receives an Allocated Namespace Attribute Changed asynchronous event from each controller that has Allocated Namespace Attribute Notices enabled.

The following is an example of how a host ~~To~~-deletes a namespace, ~~host software performs the following actions:~~

- 1) the ~~H~~host-~~software~~ should detach the namespace from all controllers;
- 2) the ~~H~~host-~~software~~ issues the Namespace Management command specifying the Delete operation for the specified namespace. On successful completion of the command, the namespace has been deleted; ~~and~~
- 3) ~~If~~ the namespace was attached to any controller(s) when deleted:
 - a) the host receives an Attached Namespace Attribute Changed asynchronous event from each of those controllers that has Attached Namespace Attribute Notices ~~are~~ enabled as described in

section 8.11.TBD2, ~~any controller(s) not processing the Namespace Management command that was attached to the namespace reports a Namespace Attribute Changed asynchronous event to the host;~~ and

- b) the host receives an Allocated Namespace Attribute Changed asynchronous event from each of those controllers that has Allocated Namespace Attribute Notices enabled as described in section 8.11.TBD2;

and

- 4) if the namespace was not attached to any controller when deleted, the host receives an Allocated Namespace Attribute Changed asynchronous event from each controller that has Allocated Namespace Attribute Notices enabled as described in section 8.11.TBD2.

8.11.TBD2 Namespace Deletion Asynchronous Event Reporting

If a delete operation is requested for ~~the~~ a namespace:

- via a command (e.g., a Namespace Management command or Capacity Management command) received on the Admin Submission Queue (e.g., not via a Management Endpoint, refer to the NVM Express Management Interface Specification), ~~is attached to another controller (i.e., a controller other than the controller processing the operation) and that~~ then:
 - each controller, to which the namespace is attached, that has Attached Namespace Attribute Notices enabled (refer to Figure 327), ~~when a delete operation is requested, other than the controller processing that delete operation, shall issue then as part of the delete operation~~ an Attached Namespace Attribute Changed Notice asynchronous event as part of the delete operation ~~is issued by that controller~~ to indicate a namespace change; and
 - each controller that has Allocated Namespace Attribute Notices enabled (refer to Figure 327) other than the controller processing that delete operation, shall issue an Allocated Namespace Attribute Changed asynchronous event as part of the delete operation to indicate a namespace change;
- or
- via any other method (e.g., a method outside the scope of this specification or via a Management Endpoint, refer to the NVM Express Management Interface Specification), then:
 - each controller, to which the namespace is attached, that has Attached Namespace Attribute Notices enabled (refer to Figure 327) shall issue an Attached Namespace Attribute Changed asynchronous event as part of the delete operation to indicate a namespace change; and
 - each controller that has Allocated Namespace Attribute Notices enabled (refer to Figure 327) shall issue an Allocated Namespace Attribute Changed asynchronous event as part of the delete operation to indicate a namespace change.

Description of Specification Changes for NVM Command Set Specification 1.0d

...

2 NVM Command Set Model

...

2.1 Theory of operation

...

2.1.1 Namespaces

...

If the controller supports Asymmetric Namespace Access Reporting (i.e., bit 3 set to '1' in the CMIC field in the Identify Controller data structure (refer to the NVM Express Base Specification)), then the NUSE field (refer to Figure 97) and the NVMCAP field (refer to Figure 97) are cleared to 0h if the relationship between the controller and the namespace is in the ANA Inaccessible state or the ANA Persistent Loss state (refer

to the Asymmetric Namespace Access Reporting section in the NVM Express Base Specification). The Attached Namespace Attribute Changed asynchronous event and the Allocated Namespace Attribute Changed asynchronous event ~~is~~are not generated for changes to these fields that result from ANA state changes as described in the Asynchronous Event Request command section in the NVM Express Base Specification. The host uses the Asymmetric Namespace Access Change Notices as an indication of these changes.

...

4 Admin Commands for the NVM Command Set

4.1 Admin Command behavior for the NVM Command Set

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4.1.1 Asynchronous Event Request command

...

Figure 77: Asynchronous Event Information – Notice

Value	Description
00h	Attached Namespace Attribute Changed: The Attached Namespace Attribute Changed asynchronous event operates as defined in the NVM Express Base Specification with the following modifications. A controller shall not send this event if: <ul style="list-style-type: none">a) the value in the Namespace Utilization field (refer to Figure 97) has changed, as this is a frequent event that does not require action by the host; ora) capacity information (i.e., the NUSE field and the NVMCAP field) returned in the Identify Namespace data structure (refer to Figure 97) changed as a result of an ANA state change.
05h	LBA Status Information Alert: The criteria for generating an LBA Status Information Alert Notice event have been met (refer to section 5.8.1). Information about Potentially Unrecoverable LBAs is available in the LBA Status Information log page (refer to section 4.1.4.5). To clear this event, the host issues a Get Log Page command with Retain Asynchronous Event bit cleared to '0' for the LBA Status Information log.
09h	Allocated Namespace Attribute Changed: The Allocated Namespace Attribute Changed asynchronous event operates as defined in the NVM Express Base Specification with the following modifications. A controller shall not send this event if: <ul style="list-style-type: none">b) the value in the Namespace Utilization field (refer to Figure 97) has changed, as this is a frequent event that does not require action by the host; orc) capacity information (i.e., the NUSE field and the NVMCAP field) returned in the Identify Namespace data structure (refer to Figure 97) changed as a result of an ANA state change.

...

Description of Specification Changes for NVM Express Management Interface Specification 1.2d

...

5 Management Interface Command Set

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5.3 Controller Health Status Poll

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Figure 81: Controller Health Data Structure (CHDS)

Bytes	Description																		
01:00	Controller Identifier (CTLID): This field shall indicate specifies the Controller Identifier of the Controller with which the data contained in this data structure is associated.																		
03:02	Controller Status (CSTS): This field reports the Controller status.																		
	<table><tr><th>Bits</th><th>Reset</th><th>Description</th></tr><tr><td>...</td><td>...</td><td>...</td></tr><tr><td>07</td><td>HwInit</td><td>Firmware Activated (FA): This bit is set to '1' when If a new firmware image is activated, then this bit shall be set to '1'. Firmware activation is described in the NVM Express Base Specification. The reset value of this bit is set to '1' if If a reset caused a new firmware image to be activated, then the reset value of this bit shall be '1'. If a Controller Health Status Poll command is processed with the Clear Changed Flags bit set to '1', then this bit shall be cleared to '0'.</td></tr><tr><td>06</td><td>0</td><td>Namespace Attribute Changed (NAC): This bit shall be is-set to '1' due to any condition that is capable of causingunder the same conditions that causes the Allocated Namespace Attribute Changed asynchronous eventto be sent with the exception that (e.g., exclusions to sending the Allocated Namespace Attribute Changed asynchronous event for specific Controllers do not prevent this bit from being set to '1'). If Allocated Namespace Attribute Notices are not required to be enabled and no Asynchronous Event Request commands are required to be outstanding in order for this bit to be set to '1' as specified in (refer to the NVM Express Base Specification). This bit may be set to '1' regardless of whether Namespace Attribute Notices are enabled or not. If a Controller Health Status Poll command is processed with the Clear Changed Flags bit set to '1', then this bit shall be cleared to '0'.</td></tr><tr><td>05</td><td>0</td><td>Controller Enable Change Occurred (CECO): This bit is set to '1' when the Enable bit (refer to CC.EN in the NVM Express Base Specification) changes state.</td></tr><tr><td>...</td><td>...</td><td>...</td></tr></table>	Bits	Reset	Description	07	HwInit	Firmware Activated (FA): This bit is set to '1' when If a new firmware image is activated, then this bit shall be set to '1'. Firmware activation is described in the NVM Express Base Specification. The reset value of this bit is set to '1' if If a reset caused a new firmware image to be activated, then the reset value of this bit shall be '1'. If a Controller Health Status Poll command is processed with the Clear Changed Flags bit set to '1', then this bit shall be cleared to '0'.	06	0	Namespace Attribute Changed (NAC): This bit shall be is-set to '1' due to any condition that is capable of causing under the same conditions that causes the Allocated Namespace Attribute Changed asynchronous event to be sent with the exception that (e.g., exclusions to sending the Allocated Namespace Attribute Changed asynchronous event for specific Controllers do not prevent this bit from being set to '1'). If Allocated Namespace Attribute Notices are not required to be enabled and no Asynchronous Event Request commands are required to be outstanding in order for this bit to be set to '1' as specified in (refer to the NVM Express Base Specification). This bit may be set to '1' regardless of whether Namespace Attribute Notices are enabled or not. If a Controller Health Status Poll command is processed with the Clear Changed Flags bit set to '1', then this bit shall be cleared to '0'.	05	0	Controller Enable Change Occurred (CECO): This bit is set to '1' when the Enable bit (refer to CC.EN in the NVM Express Base Specification) changes state.
	Bits	Reset	Description																
																
	07	HwInit	Firmware Activated (FA): This bit is set to '1' when If a new firmware image is activated, then this bit shall be set to '1'. Firmware activation is described in the NVM Express Base Specification. The reset value of this bit is set to '1' if If a reset caused a new firmware image to be activated, then the reset value of this bit shall be '1'. If a Controller Health Status Poll command is processed with the Clear Changed Flags bit set to '1', then this bit shall be cleared to '0'.																
	06	0	Namespace Attribute Changed (NAC): This bit shall be is-set to '1' due to any condition that is capable of causing under the same conditions that causes the Allocated Namespace Attribute Changed asynchronous event to be sent with the exception that (e.g., exclusions to sending the Allocated Namespace Attribute Changed asynchronous event for specific Controllers do not prevent this bit from being set to '1'). If Allocated Namespace Attribute Notices are not required to be enabled and no Asynchronous Event Request commands are required to be outstanding in order for this bit to be set to '1' as specified in (refer to the NVM Express Base Specification). This bit may be set to '1' regardless of whether Namespace Attribute Notices are enabled or not. If a Controller Health Status Poll command is processed with the Clear Changed Flags bit set to '1', then this bit shall be cleared to '0'.																
	05	0	Controller Enable Change Occurred (CECO): This bit is set to '1' when the Enable bit (refer to CC.EN in the NVM Express Base Specification) changes state.																
...																	
05:04	Composite Temperature (CTEMP): This field indicates contains a value corresponding to a temperature in Kelvins that represents the current composite temperature of the Controller and Namespace(s) associated with that Controller. The value of this field shall indicate corresponds to the value of the Composite Temperature field in the Controller's SMART / Health Information Log page.																		
...	...																		

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6 NVM Express Admin Command Set

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6.3 Get Log Page

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Figure 123: Management Endpoint – Log Page Support

Log Page Name ³	Log Identifier	Requirements ¹	
		NVMe Storage Device	NVMe Enclosure
Supported Log Pages	00h	M ²	M ²
Error Information	01h	M	M
...
Changed Attached Namespace List	04h	O	O
...
Changed Allocated Namespace List	1Ch	O	O
...

Figure 123: Management Endpoint – Log Page Support

Log Page Name ³	Log Identifier	Requirements ¹	
		NVMe Storage Device	NVMe Enclosure
Discovery	70h	O	O
Reservation Notification	80h	O	O
Sanitize Status	81h	O	O
Changed Zone List ⁵	BFh	O	O
Notes: 1. O = Optional, M = Mandatory, P = Prohibited. 2. Optional for versions 1.1 and earlier of this specification. 3. Refer to the NVM Express Base Specification unless another footnote specifies otherwise. 4. Refer to the NVM Command Set Specification. 5. Refer to the Zoned Namespace Command Set Specification.			