

UNH-IOL NVMe Testing Service

Test Plan for NVMe ZNS Conformance
Version 15.0
Target Specification: NVMe ZNS 1.0
Technical Document



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MODIFICATION RECORD

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David Woolf:

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David Woolf

UNH InterOperability Laboratory

INTRODUCTION

The University of New Hampshire’s InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards-based products by providing a neutral environment where a product can be tested against other implementations of a common standard, both in terms of interoperability and conformance. This particular suite of tests has been developed to help implementers evaluate the NVMe ZNS functionality of their products. This test suite is aimed at validating products in support of the work being directed by the NVMe Organization.

These tests are designed to determine if a product conforms to specifications defined in the NVMe ZNS specification, hereafter referred to as the “NVMe ZNS Specification”). Successful completion of these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function properly in many NVMe ZNS environments.

The tests contained in this document are organized in order to simplify the identification of information related to a test, and to facilitate in the actual testing process. Tests are separated into groups, primarily in order to reduce setup time in the lab environment, however the different groups typically also tend to focus on specific aspects of device functionality. A two-number, dot-notated naming system is used to catalog the tests. This format allows for the addition of future tests in the appropriate groups without requiring the renumbering of the subsequent tests.

The test definitions themselves are intended to provide a high-level description of the motivation, resources, procedures, and methodologies specific to each test. Formally, each test description contains the following sections:

Purpose

The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level.

References

This section specifies all reference material *external* to the test suite, including the specific references for the test in question, and any other references that might be helpful in understanding the test methodology and/or test results. External sources are always referenced by a bracketed number (e.g., [1]) when mentioned in the test description. Any other references in the test description that are not indicated in this manner refer to elements within the test suite document itself (e.g., “Appendix 5.A”, or “Table 5.1.1–1”).

Resource Requirements

The requirements section specifies the test hardware and/or software needed to perform the test. This is generally expressed in terms of minimum requirements, however in some cases specific equipment manufacturer/model information may be provided.

Last Modification

This specifies the date of the last modification to this test.

Discussion

The discussion covers the assumptions made in the design or implementation of the test, as well as known limitations. Other items specific to the test are covered here as well.

Test Setup

The setup section describes the initial configuration of the test environment. Small changes in the configuration should not be included here, and are generally covered in the test procedure section (next).

Procedure

The procedure section of the test description contains the systematic instructions for carrying out the test. It provides a cookbook approach to testing, and may be interspersed with observable results. These procedures should be the ideal test methodology, independent of specific tool limitations or restrictions.

Observable Results

This section lists the specific observable items that can be examined by the tester in order to verify that the DUT is operating properly. When multiple values for an observable are possible, this section provides a short discussion on how to interpret them. The determination of a pass or fail outcome for a particular test is generally based on the successful (or unsuccessful) detection of a specific observable.

Possible Problems

This section contains a description of known issues with the test procedure, which may affect test results in certain situations. It may also refer the reader to test suite appendices and/or other external sources that may provide more detail regarding these issues.

REFERENCES

The following documents are referenced in this text:

1. NVMe Zoned Namespaces Command Set Specification Revision 1.0 (June 4, 2020)

ABBREVIATIONS

The following abbreviations are applied to the test titles of each of the tests described in this document for indicating the status of test requirements.

M - Mandatory

FYI - FYI

IP - In Progress

Group 1: Zoned Admin Command Set

Overview:

This section describes a method for performing conformance verification for NVMe ZNS products implementing Zoned Admin Commands defined in Chapter 3 of the NVMe ZNS Specification.

Notes:

The preliminary draft descriptions for the tests defined in this group are considered complete, and the tests are pending implementation (during which time additional revisions/modifications are likely to occur).

Test 1.1 – Identify Namespace Data Structures (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process an Identify Command.

References:

[1] NVMe ZNS Specification 3.1

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 7, 2021

Discussion: The Zoned Namespace Command Set supports two I/O Command Set specific Identify Namespace data structures:

- a) the NVM Command Set Identify Namespace data structure; and
- b) the Zoned Namespace Command Set Identify Namespace data structure.

Test Setup: See Appendix A.

Case 1: Zoned Namespace Command Set Identify Namespace Data Structure (CNS 05h) (FYI)

Test Procedure:

1. Configure the Testing Station to transmit an Identify Command with CNS=05h.

Observable Results:

1. Verify that the Identify command completes with Status Success.
2. Verify that the ZSZE value is not cleared to 0h.
3. Verify that the MOR field is less than or equal to the MAR field.

Case 2: Zoned Namespace Command Set Identify Controller Data Structure (CNS 06h) (FYI)

Test Procedure:

1. Configure the Testing Station to transmit an Identify Command with CNS=01h and read the MDTS field.
2. Configure the Testing Station to transmit an Identify Command with CNS=06h and read the ZASL field.

Observable Results:

1. Verify that the Identify command completes with Status Success.
2. Verify that the ZASL field is less than or equal to the MDTS field.

Possible Problems: None.

Test 1.2 – Asynchronous Events (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly generate Asynchronous Event Notifications when a Zone Descriptor changes.

References:

[1] NVMe ZNS Specification 3.3

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 25, 2021

Discussion: If enabled, an Asynchronous Event is transmitted when a Zone Descriptor is changed.

Test Setup: See Appendix A.

Case 1: Zoned Descriptor Changed Notice Enabled (FYI)

Test Procedure:

1. Configure the Testing Station to send an Identify Command for CNS 01h to the DUT.
2. Check Bit 27 of the Optional Asynchronous Events Supported (OAES) field in the Identify Controller Data Structure, I/O Command Set Independent (CNS 01h). If this bit is set to 0 then this test is not applicable.
3. Configure the Testing Station to transmit a Set Feature command for FID 0Bh Asynchronous Event Configuration to set Zone Descriptor Changed Notices to 1.
4. Perform an action on a Zone which will generate a Zone Descriptor Changed asynchronous event notice. One such action may be a Format NVM command which will cause the Zone to transition to the ZSE or ZSO state.
5. Wait for the DUT to issue an Asynchronous Event Notification with a Zoned Descriptor Changed Notice.
6. Configure the Testing Station to transmit a Get Log Page command for LID BFh Changed Zone List.
7. Configure the Testing Station to transmit a Zone Receive command with Action set to Report Zones for any zone that is indicated as changed in the received Changed Zone List.

Observable Results:

1. Verify that the DUT generated an Asynchronous Notification in response to the Zone Descriptor being changed.
2. Verify that the Report Zones data structure returned by the DUT in response to the Zone Receive command with Action set to Report Zones indicated that the Zone was in the ZSE or ZSO state, if a Format NVM command was used to cause the Zone Descriptor Changed asynchronous event notice. If another command was used, ensure that the Report Zones indicated that the Zone was in the expected state.

Case 2: Zoned Descriptor Changed Notice Disabled (FYI)

Test Procedure:

1. Configure the Testing Station to send an Identify Command for CNS 01h to the DUT.
2. Check Bit 27 of the Optional Asynchronous Events Supported (OAES) field in the Identify Controller Data Structure, I/O Command Set Independent (CNS 01h). If this bit is set to 0 then this test is not applicable.
3. Configure the Testing Station to transmit a Set Feature command for FID 0Bh Asynchronous Event Configuration to set Zone Descriptor Changed Notices to 0.
4. Perform an action on a Zone which normally would generate a Zone Descriptor Changed asynchronous event notice. One such action may be a Format NVM command which will cause the Zone to transition to the ZSE or ZSO state. It may be best to use the same action as used in Case 1 above.
5. Configure the Testing Station to transmit a Get Log Page command for LID BFh Changed Zone List.
6. Configure the Testing Station to transmit a Zone Receive command with Action set to Report Zones for any zone that is indicated as changed in the received Changed Zone List.

Observable Results:

1. Verify that the DUT did not generate an Asynchronous Notification in response to the Zone Descriptor being changed.
2. Verify that the Report Zones data structure returned by the DUT in response to the Zone Receive command with Action set to Report Zones indicated that the Zone was in the ZSE or ZSO state, if a Format NVM command was used to cause the Zone Descriptor Changed asynchronous event notice. If another command was used, ensure that the Report Zones indicated that the Zone was in the expected state.

Possible Problems: None.

Test 1.3 – Log Pages (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Get Log Page Command.

References:

[1] NVMe ZNS Specification 3.4

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 21, 2021

Discussion: The Zoned Namespace Command Set supports Log Pages specific to ZNS.

Test Setup: See Appendix A.

Case 1: Get Log Page: Changed Zone List (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Get Log Page Command with LID=BFh Changed Zone List.

Observable Results:

1. Verify that the Get Log Page command completes with Status Success.
2. Verify that the each ZSLBA value appears only once in the Zone Identifier List and that unused entries are zero-filled.
3. Verify that the controller sets the Number of Zone Identifiers field in the log page to the number of valid entries that follow.

Case 2: Get Log Page: SMART / Health Information Log (FYI)

Test Procedure:

1. Determine support for the Zone Append Command by performing the following steps. If the Zone Append command is not support this test is not applicable.
 - a. Configure the Testing Station to set CC.CSS to indicate support for ZNS.
 - b. Configure the Testing Station to perform a Get Log Page command for LID=05h, Commands Supported and Effects.
 - c. Check the CSUPP bit in IOCS125 of the returned log page. IOCS125 corresponds to support for the Zone Append command. The CSUPP bit indicates if this command is supported or not.
2. Configure the Testing Station to transmit a Get Log Page Command with LID=02h SMART/ Health Information.
3. Configure the Testing Station to transmit a Zone Append command, with valid ZSLBA and PRINFO fields.
4. Configure the Testing Station to transmit a Get Log Page Command with LID=02h SMART/ Health Information

Observable Results:

1. Verify that the second SMART / Health Information Log returned had a higher Data Units Written value than the first SMART / Health Information Log proportional to the Zone Append command which was performed.

Case 3: Get Log Page: Endurance Group Log (FYI)

Test Procedure:

1. Configure the Testing Station to transmit an Identify Command with CNS=01h and read the CTRATT field.
2. Determine if Endurance Groups are supported by checking Bit 4 of the CTRATT field. If this bit is set to 0 then this test is not applicable.

3. Determine support for the Zone Append Command by performing the following steps. If the Zone Append command is not support this test is not applicable.
 - a. Configure the Testing Station to set CC.CSS to indicate support for ZNS.
 - b. Configure the Testing Station to perform a Get Log Page command for LID=05h, Commands Supported and Effects.
 - c. Check the CSUPP bit in IOCS125 of the returned log page. IOCS125 corresponds to support for the Zone Append command. The CSUPP bit indicates if this command is supported or not.
4. Configure the Testing Station to transmit a Get Log Page Command with LID=09h Endurance Group Log.
5. Configure the Testing Station to transmit a Zone Append command, with valid ZSLBA and PRINFO fields.
6. Configure the Testing Station to transmit a Get Log Page Command with LID=09h Endurance Group Log.

Observable Results:

1. Verify that the second Endurance Group Log returned had a higher Data Units Written value than the first Endurance Group Log proportional to the Zone Append command which was performed.

Possible Problems: None.

Group 2: Zoned I/O Commands

Overview:

This section describes a method for performing conformance verification for NVMe ZNS products implementing Zoned I/O Commands defined in Chapter 4 of the NVMe ZNS Specification.

Notes:

The preliminary draft descriptions for the tests defined in this group are considered complete, and the tests are pending implementation (during which time additional revisions/modifications are likely to occur).

Test 2.1 – Zone Management Send: Finish Zone (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Send command.

References:

[1] NVMe ZNS Specification 4.3.1.2

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 7, 2021

Discussion: The Zone Management Send command requests an action on one or more zones. The command uses the Data Pointer, Command Dword 10, Command Dword 11 and Command Dword 13 fields. All other command specific fields are reserved. The Zoned Management Send command supports the following actions: Close Zone, Finish Zone, Open Zone, Reset Zone, Offline Zone, Set Zone Descriptor Extension.

Test Setup: See Appendix A.

Case 1: ZSIO Finish Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 2: ZSEO Finish Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 3: ZSC Finish Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 4: ZSE Finish Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSE: Empty state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 5: ZSF Finish Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 6: ZSRO Finish Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSRO: Read Only state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 7: ZSO Finish Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSO: Offline state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 8: ZSIO Finish Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=1, and a valid SLBA, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.
3. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 9: ZSEO Finish Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=1, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.
3. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 10: ZSC Finish Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=1, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that each Zone Management Send command completes with Status Success.
3. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 11: ZSC Finish Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state. This can be accomplished by configuring the Testing Station acting as a Host to send a Zone Management Send command with the action of Finish Zone and Select All=1, and a valid SLBA.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Perform a Sequential Write operation to the Zone in the ZSF state.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSF: Full State.
2. Verify that the Write operation is aborted with status Zone is Full (B9h).
3. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Possible Problems: None.

Test 2.2 – Zone Management Send: Open Zone (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Send command.

References:

[1] NVMe ZNS Specification 4.3.1.3

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 7, 2021

Discussion: The Zone Management Send command requests an action on one or more zones. The command uses the Data Pointer, Command Dword 10, Command Dword 11 and Command Dword 13 fields. All other command specific fields are reserved. The Zoned Management Send command supports the following actions: Close Zone, Finish Zone, Open Zone, Reset Zone, Offline Zone, Set Zone Descriptor Extension.

Test Setup: See Appendix A.

Case 1: ZSIO Open Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSEO: Explicitly Opened State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 2: ZSC Open Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSEO: Explicitly Opened State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 3: ZSE Open Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSE: Empty state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSEO: Explicitly Opened State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 4: ZSEO Open Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSEO: Explicitly Opened State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 5: ZSRO Open Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSRO: Read Only state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status 'Invalid Zone State Transition' BFh.

Case 6: ZSO Open Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSO: Offline state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of OpenZone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status 'Invalid Zone State Transition' BFh.

Case 7: ZSF Open Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status 'Invalid Zone State Transition' BFh

Case 8: ZSC Open Zone Select All=1 valid SLBA (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=1, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSEO: Explicitly Opened State. Verify that each Zone Management Send command completes with Status Success.
2. Alternately, if the operation causes the number of Open Resources to exceed the value specified by the Maximum Open Resources field, then the command shall be aborted with a status code of Too Many Open Zones, and no zone state transitions shall occur.
3. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 9: ZSC Open Zone Select All=1 invalid SLBA (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Open Zone and Select All=1, and an invalid SLBA, which should be ignored since the Select All bit is set to 1.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSEO: Explicitly Opened State. Verify that each Zone Management Send command completes with Status Success.
2. Alternately, if the operation causes the number of Open Resources to exceed the value specified by the Maximum Open Resources field, then the command shall be aborted with a status code of Too Many Open Zones, and no zone state transitions shall occur.
3. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Possible Problems: None.

Test 2.3 – Zone Management Send: Reset Zone (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Send command.

References:

[1] NVMe ZNS Specification 4.3.1.4

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 7, 2021

Discussion: The Zone Management Send command requests an action on one or more zones. The command uses the Data Pointer, Command Dword 10, Command Dword 11 and Command Dword 13 fields. All other command specific fields are reserved. The Zoned Management Send command supports the following actions: Close Zone, Finish Zone, Open Zone, Reset Zone, Offline Zone, Set Zone Descriptor Extension.

Test Setup: See Appendix A.

Case 1: ZSIO Reset Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 2: ZSEO Reset Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 3: ZSC Reset Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 4: ZSF Reset Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 5: ZSE Reset Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSE: Empty state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 6: ZSRO Reset Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSRO: Read Only state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 7: ZSO Reset Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSO: Offline state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 8: ZSIO Reset Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=1, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that the final Zone Descriptor returned has set the Write Pointer zone attribute to the ZSLBA of the zone.
3. Verify that the final Zone Descriptor returned has the following zone attribute bits cleared to 0:
 - a. Zone Descriptor Extension Valid
 - b. Finish Zone Recommended
 - c. Reset Zone Recommended
 - d. Zone Finished by Controller
4. Verify that each Zone Management Send command completes with Status Success.
5. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 9: ZSEO Reset Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=1, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that the final Zone Descriptor returned has set the Write Pointer zone attribute to the ZSLBA of the zone.
3. Verify that the final Zone Descriptor returned has the following zone attribute bits cleared to 0:
 - a. Zone Descriptor Extension Valid
 - b. Finish Zone Recommended
 - c. Reset Zone Recommended
 - d. Zone Finished by Controller
4. Verify that each Zone Management Send command completes with Status Success.
5. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 10: ZSC Reset Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=1, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that the final Zone Descriptor returned has set the Write Pointer zone attribute to the ZSLBA of the zone.
3. Verify that the final Zone Descriptor returned has the following zone attribute bits cleared to 0:
 - a. Zone Descriptor Extension Valid
 - b. Finish Zone Recommended
 - c. Reset Zone Recommended
 - d. Zone Finished by Controller
4. Verify that each Zone Management Send command completes with Status Success.
5. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 11: ZSF Reset Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Reset Zone and Select All=1, and a valid SLBA.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSE: Empty State.
2. Verify that the final Zone Descriptor returned has set the Write Pointer zone attribute to the ZSLBA of the zone.
3. Verify that the final Zone Descriptor returned has the following zone attribute bits cleared to 0:
 - a. Zone Descriptor Extension Valid
 - b. Finish Zone Recommended
 - c. Reset Zone Recommended
 - d. Zone Finished by Controller
4. Verify that each Zone Management Send command completes with Status Success.
5. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Possible Problems: None.

Test 2.4 – Zone Management Send: Offline Zone (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Send command.

References:

[1] NVMe ZNS Specification 4.3.1.4

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 7, 2021

Discussion: The Zone Management Send command requests an action on one or more zones. The command uses the Data Pointer, Command Dword 10, Command Dword 11 and Command Dword 13 fields. All other command specific fields are reserved. The Zoned Management Send command supports the following actions: Close Zone, Finish Zone, Open Zone, Reset Zone, Offline Zone, Set Zone Descriptor Extension.

Test Setup: See Appendix A.

Case 1: ZSRO Offline Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSRO: Read Only state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Offline Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSO: Offline State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 2: ZSO Offline Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSO: Offline state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Offline Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSO: Offline State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 3: ZSIO Offline Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Offline Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 4: ZSEO Offline Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Offline Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 5: ZSC Offline Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Offline Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 6: ZSF Offline Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Offline Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 7: ZSE Offline Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSE: Empty state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Offline Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.

2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Possible Problems: None.

Test 2.5 – Zone Management Send: Set Zone Descriptor Extension (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Send command.

References:

[1] NVMe ZNS Specification 4.3.1.4

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 7, 2021

Discussion: The Zone Management Send command requests an action on one or more zones. The command uses the Data Pointer, Command Dword 10, Command Dword 11 and Command Dword 13 fields. All other command specific fields are reserved. The Zoned Management Send command supports the following actions: Close Zone, Finish Zone, Open Zone, Reset Zone, Offline Zone, Set Zone Descriptor Extension.

Test Setup: See Appendix A.

Case 1: ZSE Set Zone Descriptor Extension Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSE: Empty state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State at the end of the test is ZSC: Closed State.
2. Verify that each Zone Management Send command completes with Status Success.

Case 2: ZSRO Set Zone Descriptor Extension Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSRO: Read Only state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status 'Invalid Zone State Transition' BFh.

Case 3: ZSO Set Zone Descriptor Extension Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSO: Offline state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 4: ZSIO Set Zone Descriptor Extension Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 5: ZSEO Set Zone Descriptor Extension Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 6: ZSC Set Zone Descriptor Extension Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 7: ZSF Set Zone Descriptor Extension Zone Select All=0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status ‘Invalid Zone State Transition’ BFh.

Case 8: All States Set Zone Descriptor Extension Zone Select All=1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSF: Full state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
5. Repeat for the following starting states: ZSIO, ZSEO, ZSRO, ZSC, ZSE, ZSO.

Observable Results:

1. Verify that the current Zone State between steps 2 and 4 is unchanged.
2. Verify that the Zone Management Send command completes with Status 'Invalid Field in Command'.
3. Verify that the SLBA field is ignored and the Zone Management Send command completes according to Select All =1.

Case 9: Zone Descriptor Extension Size = 0 (FYI)

Test Procedure:

1. Perform an Identify Command for CNS=05h and check the Zone Descriptor Extension Field Size value in the Identify Namespace Data Structure. If this is not set to 0h this test is not applicable.
2. Configure the Testing Station acting as a Host to send a Zone Management Send command with the action of Set Zone Descriptor Extension Zone and Select All=0.

Observable Results:

1. Verify that the Zone Management Send command completes with Status 'Invalid Field in Command'.

Possible Problems: None.

Test 2.6 – Zone Management Receive: Report Zones (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Receive command.

References:

[1] NVMe ZNS Specification 4.4

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 21, 2021

Discussion: The Zone Management Receive command returns a data buffer that contains information about zones.

Test Setup: See Appendix A.

Case 1: Report Zones: All Zones, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 0h List all zones

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 2: Report Zones: All Zones, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 0h List all zones

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 3: Report Zones: ZSE, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSE state.

2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 1h List the zones in the ZSE: Empty State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 4: Report Zones: ZSE, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSE state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 1h List the zones in the ZSE: Empty State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 5: Report Zones: ZSIO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSIO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 2h List the zones in the ZSIO: Implicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 6: Report Zones: ZSIO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSIO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 2h List the zones in the ZSIO: Implicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 7: Report Zones: ZSEO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSEO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 3h List the zones in the ZSEO: Explicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 8: Report Zones: ZSEO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSEO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 3h List the zones in the ZSEO: Explicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.

4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 9: Report Zones: ZSC, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSC state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 4h List the zones in the ZSC: Closed state

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 10: Report Zones: ZSC, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSC state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 4h List the zones in the ZSC: Closed state

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 11: Report Zones: ZSF, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSF state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 5h List the zones in the ZSF: Full State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.

2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 12: Report Zones: ZSF, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSF state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 5h List the zones in the ZSF: Full State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 13: Report Zones: ZSRO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSRO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 6h List the zones in the ZSRO: Ready Only State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 14: Report Zones: ZSRO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSRO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 6h List the zones in the ZSRO: Ready Only State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 15: Report Zones: ZSO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 7h List the zones in the ZSO: Offline State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 16: Report Zones: ZSO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT in to the ZSO state.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 7h List the zones in the ZSO: Offline State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Possible Problems: None.

Test 2.7 – Zone Management Receive: Extended Report Zones Correct Format (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Receive command.

References:

[1] NVMe ZNS Specification 4.4

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 21, 2021

Discussion: The Zone Management Receive command returns a data buffer that contains information about zones.

Test Setup: See Appendix A.

Case 1: Extended Report Zones: All Zones, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 0h List all zones

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 2: Extended Report Zones: All Zones, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 0h List all zones

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 3: Extended Report Zones: ZSE, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSE state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 1h List the zones in the ZSE: Empty State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 4: Extended Report Zones: ZSE, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSE state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 1h List the zones in the ZSE: Empty State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 5: Extended Report Zones: ZSIO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSIO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:

- a. 2h List the zones in the ZSIO: Implicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 6: Extended Report Zones: ZSIO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSIO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 2h List the zones in the ZSIO: Implicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 7: Extended Report Zones: ZSEO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSEO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 3h List the zones in the ZSEO: Explicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.

4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 8: Extended Report Zones: ZSEO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSEO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 3h List the zones in the ZSEO: Explicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 9: Extended Report Zones: ZSC, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSC state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 4h List the zones in the ZSC: Closed state

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 10: Extended Report Zones: ZSC, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSC state.

3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 4h List the zones in the ZSC: Closed state

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 11: Extended Report Zones: ZSF, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSF state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 5h List the zones in the ZSF: Full State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 12: Extended Report Zones: ZSF, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSF state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 5h List the zones in the ZSF: Full State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.

3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 13: Extended Report Zones: ZSRO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSRO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 6h List the zones in the ZSRO: Ready Only State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 14: Extended Report Zones: ZSRO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSRO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 6h List the zones in the ZSRO: Ready Only State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 15: Extended Report Zones: ZSO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 7h List the zones in the ZSO: Offline State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Case 16: Extended Report Zones: ZSO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a non-zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 7h List the zones in the ZSO: Offline State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Success.
2. Verify that the DUT only returns zone descriptors of zones for which the ZSLBA value is greater than or equal to the ZSLBA value of the zone specified by the SLBA value in the Zone Management Receive command.
3. Verify that the DUT only returns zone descriptors which match the criteria in the Zone Receive Action Specific field.
4. Verify that the zone descriptors returned by the DUT are sorted in ascending order by the ZSLBA value of each zone.

Possible Problems: None.

Test 2.8 – Zone Management Receive: Extended Report Zones Incorrect Format (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Management Receive command.

References:

[1] NVMe ZNS Specification 4.4

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 21, 2021

Discussion: The Zone Management Receive command returns a data buffer that contains information about zones.

Test Setup: See Appendix A.

Case 1: Extended Report Zones: All Zones, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 0h List all zones

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 2: Extended Report Zones: All Zones, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 0h List all zones

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 3: Extended Report Zones: ZSE, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSE state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:

- a. 1h List the zones in the ZSE: Empty State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 4: Extended Report Zones: ZSE, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSE state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 1h List the zones in the ZSE: Empty State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 5: Extended Report Zones: ZSIO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSIO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 2h List the zones in the ZSIO: Implicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 6: Extended Report Zones: ZSIO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSIO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 2h List the zones in the ZSIO: Implicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 7: Extended Report Zones: ZSEO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSEO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 3h List the zones in the ZSEO: Explicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 8: Extended Report Zones: ZSEO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSEO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 3h List the zones in the ZSEO: Explicitly Opened State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 9: Extended Report Zones: ZSC, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSC state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 4h List the zones in the ZSC: Closed state

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 10: Extended Report Zones: ZSC, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSC state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 4h List the zones in the ZSC: Closed state

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 11: Extended Report Zones: ZSF, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSF state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 5h List the zones in the ZSF: Full State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 12: Extended Report Zones: ZSF, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSF state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 5h List the zones in the ZSF: Full State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 13: Extended Report Zones: ZSRO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSRO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 6h List the zones in the ZSRO: Ready Only State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 14: Extended Report Zones: ZSRO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.

2. Configure the Testing Station to put the DUT in to the ZSRO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 6h List the zones in the ZSRO: Ready Only State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 15: Extended Report Zones: ZSO, Partial Report = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 0. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 7h List the zones in the ZSO: Offline State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Case 16: Extended Report Zones: ZSO, Partial Report = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to transmit a Format NVM command to the DUT to format a given namespace with a zero Zone Descriptor Extension Size. The following steps in the test procedure should be performed on this same namespace.
2. Configure the Testing Station to put the DUT in to the ZSO state.
3. Configure the Testing Station to transmit a Zone Management Receive command, with action set to Extended Report Zones, with the Partial Report bit set to 1. Repeat the command for the following Zone Receive Action Specific Field:
 - a. 7h List the zones in the ZSO: Offline State

Observable Results:

1. Verify that each Zone Management Receive command completes with Status Invalid Field in Command.

Possible Problems: None.

Test 2.9 – Zone Append (FYI)

Purpose: To verify that an NVMe ZNS capable controller can properly process a Zoned Append command.

References:

[1] NVMe ZNS Specification 4.5

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 21, 2021

Discussion: The Zone Append command writes data and metadata, if applicable, to the I/O controller for the zone indicated by the ZSLBA field.

Test Setup: See Appendix A.

Case 1: Zone Append (FYI)

Test Procedure:

1. Determine support for the Zone Append Command by performing the following steps. If the Zone Append command is not support this test is not applicable.
 - a. Configure the Testing Station to set CC.CSS to indicate support for ZNS.
 - b. Configure the Testing Station to perform a Get Log Page command for LID=05h, Commands Supported and Effects.
 - c. Check the CSUPP bit in IOCS125 of the returned log page. IOCS125 corresponds to support for the Zone Append command. The CSUPP bit indicates if this command is supported or not.
2. Configure the Testing Station to transmit a Zone Append command, with valid ZSLBA and PRINFO fields.

Observable Results:

1. Verify that the Zone Append command completes successfully.

Case 2: ZSE Zone Append Incorrect Logical Block (FYI)

Test Procedure:

1. Follow the first step in Case 1 above to determine support for the Zone Append Command. If the Zone Append command is not support this test is not applicable.
2. Configure the DUT to enter the ZSE: Empty state.
3. Configure the Testing Station to transmit a Zone Append command with a ZSLBA value which does not specify the lowest logical block for the zone.

Observable Results:

1. Verify that each Zone Append command completes with Status Invalid Field in Command.

Case 3: ZSIO Zone Append Incorrect Logical Block (FYI)

Test Procedure:

1. Follow the first step in Case 1 above to determine support for the Zone Append Command. If the Zone Append command is not support this test is not applicable.
2. Configure the DUT to enter the ZSIO: Implicitly Opened state.
3. Configure the Testing Station to transmit a Zone Append command with a ZSLBA value which does not specify the lowest logical block for the zone.

Observable Results:

1. Verify that each Zone Append command completes with Status Invalid Field in Command.

Case 4: ZSEO Zone Append Incorrect Logical Block (FYI)

Test Procedure:

1. Follow the first step in Case 1 above to determine support for the Zone Append Command. If the Zone Append command is not support this test is not applicable.
2. Configure the DUT to enter the ZSEO: Explicitly Opened state.
3. Configure the Testing Station to transmit a Zone Append command with a ZSLBA value which does not specify the lowest logical block for the zone.

Observable Results:

1. Verify that each Zone Append command completes with Status Invalid Field in Command.

Case 5: ZSC Zone Append Incorrect Logical Block (FYI)

Test Procedure:

1. Follow the first step in Case 1 above to determine support for the Zone Append Command. If the Zone Append command is not support this test is not applicable.
2. Configure the DUT to enter the ZSC: Closed state.
3. Configure the Testing Station to transmit a Zone Append command with a ZSLBA value which does not specify the lowest logical block for the zone.

Observable Results:

1. Verify that each Zone Append command completes with Status Invalid Field in Command.

Case 6: Zone Append Incorrect PIREMAP for Type 1 Protection (FYI)

Test Procedure:

1. Follow the first step in Case 1 above to determine support for the Zone Append Command. If the Zone Append command is not support this test is not applicable.
2. Configure the Testing Station to transmit a Zone Append command with a PIREMAP value cleared to 0 for Type 1 protection.

Observable Results:

1. Verify that each Zone Append command completes with Status Invalid Protection Information.

Case 7: Zone Append Incorrect PIREMAP for Type 3 Protection (FYI)

Test Procedure:

1. Follow the first step in Case 1 above to determine support for the Zone Append Command. If the Zone Append command is not support this test is not applicable.
2. Configure the Testing Station to transmit a Zone Append command with a PIREMAP value set to 1 for Type 3 protection.

Observable Results:

1. Verify that each Zone Append command completes with Status Invalid Protection Information.

Possible Problems: None.

Test 2.10 – Zone State Change due to Write Operation (FYI)

Purpose: To verify that an NVMe ZNS capable controller properly changes states due to write operations.

References:

[1] NVMe ZNS Specification 2.3.11

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 26, 2021

Discussion: The write pointer for a zone in the ZSE:Empty state, the ZSIO:Implicitly Opened state, the ZSEO:Explicitly Opened state, or the ZSC:Closed state shall be increased by the number of logical blocks written on successful completion of a write operation.

Test Setup: See Appendix A.

Case 1: ZSE to ZSIO (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSE: Empty state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
5. Configure the Testing Station acting as a Host to send write operation to the zone.
6. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State after the first write operation is ZSIO: Implicitly Opened.
2. Verify that the write pointer reported for the zone in the second Zone Descriptor returned has increased by the number of logical blocks written on successful completion of the write operation relative to the write pointer in the first returned Zone Descriptor.

Case 2: ZSC to ZSIO (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
5. Configure the Testing Station acting as a Host to send write operation to the zone.
6. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the current Zone State after the first write operation is ZSIO: Implicitly Opened.
2. Verify that the write pointer reported for the zone in the second Zone Descriptor returned has increased by the number of logical blocks written on successful completion of the write operation relative to the write pointer in the first returned Zone Descriptor.

Possible Problems: None.

Test 2.11 – Failed Write Operation (FYI)

Purpose: To verify that an NVMe ZNS capable controller properly handles incorrect write operations.

References:

[1] NVMe ZNS Specification 2.3.11

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 26, 2021

Discussion: The ZNS specification identifies certain error codes to be returned when a write operation is performed on an offline or read only zone.

Test Setup: See Appendix A.

Case 1: ZSRO (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSRO: Read Only state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the attempted write operation does not change the current Zone state.
2. Verify that the write operation is aborted with status Zone is Read Only (BAh).

Case 2: ZSO (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSO: Offline state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone.
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the attempted write operation does not change the current Zone state.
2. Verify that the write operation is aborted with status Zone is Offline (BBh).

Case 3: ZSE Write Bad SLBA (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSE: Empty state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone specifying an SLBA which is not equal to the write pointer for that zone
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the attempted write operation does not change the current Zone state.
2. Verify that the write operation is aborted with status Zone Invalid Write (BCh).

Case 4: ZSIO Write Bad SLBA (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSIO: Implicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone specifying an SLBA which is not equal to the write pointer for that zone
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the attempted write operation does not change the current Zone state.
2. Verify that the write operation is aborted with status Zone Invalid Write (BCh).

Case 5: ZSEO Write Bad SLBA (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSEO: Explicitly Opened state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone specifying an SLBA which is not equal to the write pointer for that zone
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the attempted write operation does not change the current Zone state.
2. Verify that the write operation is aborted with status Zone Invalid Write (BCh).

Case 6: ZSC Write Bad SLBA (FYI)

Test Procedure:

1. Configure the Testing Station to put the DUT into the ZSC: Closed state.
2. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.
3. Configure the Testing Station acting as a Host to send write operation to the zone specifying an SLBA which is not equal to the write pointer for that zone
4. Confirm the current Zone state by querying the Zone Descriptor using a Zone Management Receive.

Observable Results:

1. Verify that the attempted write operation does not change the current Zone state.
2. Verify that the write operation is aborted with status Zone Invalid Write (BCh).

Case 7: NLB Exceeds Remaining Blocks (FYI)

Test Procedure:

1. Configure the Testing Station acting as a Host to send write operation to the zone specifying a Number of Logical blocks that exceeds the remaining number of logical blocks in that zone.

Observable Results:

1. Verify that the attempted write operation does not change the current Zone state.
2. Verify that the write operation is aborted with status Zone Invalid Write (BCh).

Possible Problems: None.

Test 2.12 – Zoned Reads (FYI)

Purpose: To verify that an NVMe ZNS capable controller properly handles Read operations.

References:

[1] NVMe ZNS Specification 2.3.1.2

Resource Requirements: Tools capable of monitoring and decoding traffic on the chosen NVMe transport.

Last Modification: January 26, 2021

Discussion: The ZNS specification identifies certain conditions for reading zones.

Test Setup: See Appendix A.

Case 1: Read Across Zone Boundaries = 1 (FYI)

Test Procedure:

1. Configure the Testing Station to send an Identify Command for CNS 05h. Check the Check the Read Across Zone Boundaries bit. If this bit is set to 0, this test is not applicable.
2. Perform a Read operation with an SLBA and Length which will span zone boundaries.

Observable Results:

1. Verify that the Read operation completes successfully.

Case 2: Read Across Zone Boundaries = 0 (FYI)

Test Procedure:

1. Configure the Testing Station to send an Identify Command for CNS 05h. Check the Check the Read Across Zone Boundaries bit. If this bit is set to 1, this test is not applicable.
2. Perform a Read operation with an SLBA and Length which will span zone boundaries.

Observable Results:

1. Verify that the Read operation is aborted with status Zone Boundary Error (B8h).

Possible Problems: None.

Appendix A: TEST SETUP

Refer to the NVMe Base Specification test plan for descriptions of valid test setups.

Appendix B: ZONE STATE TRANSITIONS REFERENCE

There are scenarios where in test procedures it is necessary to put a device into a particular state in the Zone State Machine before beginning the test procedure. Some test cases described in this document assume the Zone to be in a particular state when the test begins. The following outlines how a test procedure can move from one Zone State to any other Zone state before beginning a prescribed test procedure. This material references section 2.4 of the ZNS command set specification.

Starting Zone State	Intended Finishing Zone State	Procedure
ZSE	ZSIO	Perform a Write Operation to that zone.
	ZSEO	Perform a Zone Management Send command with action of Open Zone.
	ZSC	Perform a Zone Management Send command with action of Set Zone Descriptor Extension.
	ZSF	Perform a Zone Management Send command with action of Finish Zone.
ZSIO	ZSE	Perform a Zone Management Send command with action of Reset Zone.
	ZSEO	Perform a Zone Management Send command with action of Open Zone.
	ZSC	Perform a Zone Management Send command with action of Close Zone.
	ZSF	Perform a Zone Management Send command with action of Finish Zone.
ZSEO	ZSE	Perform a Zone Management Send command with action of Reset Zone.
	ZSC	Perform a Zone Management Send command with action of Close Zone.
	ZSF	Perform a Zone Management Send command with action of Finish Zone.
ZSC	ZSE	Perform a Zone Management Send command with action of Reset Zone.
	ZSIO	Perform a Write Operation to that zone.
	ZSEO	Perform a Zone Management Send command with action of Open Zone.
	ZSF	Perform a Zone Management Send command with action of Finish Zone.
ZSF	ZSE	Perform a Zone Management Send command with action of Reset Zone.

ZSRO	ZSO	Perform a Zone Management Send command with action of Offline Zone.
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