Testing Dual-Port NVMe SSD

Sneha Nadig, Product Application Engineer
Advantest America, Inc.
Contents

• What is Dual-Port NVMe?
• Dual-Port Functionality in NVMe
• Form Factors for Dual-Port NVMe
• Advantages of Dual-Port NVMe
• NVMe Dual-Port vs. SAS Dual-Port
• Testing Dual-Port NVMe
What is Dual-Port NVMe?

- Traditionally single x4 device is split into two x2 devices
  - Port A and Port B
- Methods to access the device:
  - Either Port A or Port B
  - Both Ports simultaneously
- Supported form factors:
  - U.2 (SFF-8639)
Santa Clara, CA
August 2018

Image Source: OCZ Storage Solutions
Enterprise PCIe Pin Out

PuPcie ➔ Enterprise PCIe (separate from SATA/SAS)
SATAa ➔ SATA Express
(Clock PCIe- mixed on SATASAS signals)
SAS4 ➔ SAS x4

Flash Memory Summit
Dual-Port Functionality in NVMe

- Dual-Port functionality can be enabled with DUALPORTEN# (E39)
- If DUALPORTEN# is left open, dual-port functionality is not enabled and device will be configured in x4
- If DUALPORTEN# is grounded, dual-port functionality is enabled and device is configured in dual x2
Form Factors for Dual-Port NVMe SSD

- Currently supported Form Factors:
  - U.2 (SFF 8639)
  - AIC
- New Form Factors:
  - EDSFF
  - NF1
Advantages of Dual-Port NVMe

- Dual Port provides failover capabilities
  - Ability to connect to two hosts simultaneously
## NVMe Dual-Port vs. SAS Dual-Port

<table>
<thead>
<tr>
<th>NVMe</th>
<th>SAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No improvement in performance</td>
<td>Significant improvement in performance for read test</td>
</tr>
<tr>
<td></td>
<td>(Read BW (simultaneous dual-port)) = 2x (non-dual port mode)</td>
</tr>
<tr>
<td>Provides failover capabilities</td>
<td>Provides failover capabilities</td>
</tr>
<tr>
<td>Overall performance (NVMe PCIe Gen 3 x4):</td>
<td>Overall performance (SAS-3) dual port mode:</td>
</tr>
<tr>
<td>• Read BW: ~3300 MB/s</td>
<td>• Read BW: ~1900 MB/s</td>
</tr>
<tr>
<td>• Read IOPS: ~800K</td>
<td>• Read IOPS: ~270K</td>
</tr>
<tr>
<td>Form Factor:</td>
<td>Form Factor:</td>
</tr>
<tr>
<td>• U.2 (SFF 8639)</td>
<td>• U.2 (SFF 8639)</td>
</tr>
<tr>
<td>• AIC</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Toshiba
Power On & Link Status of Dual-Port (1/2)

• Link Status display with `lspci`

```bash
$ lspci -s 0d:00.0 -vvv | grep -A6 LinkCap

linkCap: Port #0, Speed 8GT/s, Width x8, ASIC LS, Exit Latency LCs <4us, L1 unlimited
ClockNom- Surp8le- LLAntTop- BmNot- ASPXOptComp+
LinkCtrl: ASPX Disabled; 128 bytes Disabled; CoreClk+
ExtSync- ClockPw- AuthSoft- BUint- AuthSMInt-
LinkStat: Speed 8GT/s, Width x8, TxFrm- Train- ClockClk+ TAActive- EVMgmt- ASUMgmt-
DevCaps: Completion Timeout: Range AB, TimeoutDis+, LTR-, OFF Not Supported
AtomicOpsCap: 32bit- 64bit- 128bitCAS-

$ lspci -s 0d:00.0 -vvv | grep -A6 LinkCap

linkCap: Port #1, Speed 8GT/s, Width x8, ASIC LS, Exit Latency LCs <4us, L1 unlimited
ClockNom- Surp8le- LLAntTop- BmNot- ASPXOptComp+
LinkCtrl: ASPX Disabled; 128 bytes Disabled; CoreClk+
ExtSync- ClockPw- AuthSoft- BUint- AuthSMInt-
LinkStat: Speed 8GT/s, Width x8, TxFrm- Train- ClockClk+ TAActive- EVMgmt- ASUMgmt-
DevCaps: Completion Timeout: Range AB, TimeoutDis+, LTR-, OFF Not Supported
AtomicOpsCap: 32bit- 64bit- 128bitCAS-
```
Power On & Link Status of Dual-Port (2/2)

• Link Status display with Advantest MPT3000 platform

```
************************************************************
PCIe Port a Link Status:
LinkUp L0     = true
LTSSM        = 0x10, LTSSM_L0
LinkWidth     = x2
LinkSpeed     = 8.0G
ActiveLanes   = 00000011 (0x03)
ValidLanes    = 00000011 (0x03)
LinkUpCount   = 1
LinkRetrainCnt = 3
************************************************************

************************************************************
PCIe Port b Link Status:
LinkUp L0     = true
LTSSM        = 0x10, LTSSM_L0
LinkWidth     = x2
LinkSpeed     = 8.0G
ActiveLanes   = 00000011 (0x03)
ValidLanes    = 00000011 (0x03)
LinkUpCount   = 1
LinkRetrainCnt = 3
************************************************************

Power up PCIe levels!
Power up was successful
```
Testing Dual-Port NVMe
(Production Test Flow – 1/4)

- User can access one port at a particular point of time
  - Either Port A or Port B
- Complete LBA address range can be accessed from both ports
Testing Dual-Port NVMe (Production Test Flow – 2/4)
Testing Dual-Port NVMe
(Production Test Flow – 3/4)

- Example Test Case:
  - Write to a particular LBA range using Port A
  - Read from the same LBA address range using Port B
Testing Dual-Port NVMe (Production Test Flow– 4/4)

- Checks if both Port A and Port B is functional
- Checks if same link rate can be negotiated on both Ports
- Part of Production Test Flow
Testing Dual-Port NVMe (QA Test Flow – 1/4)

- User can access both ports simultaneously.
- *Simultaneous Read*: Both ports can access the same LBA address range
- *Simultaneous Write*: LBA address range should be exclusive to the ports.
Testing Dual-Port NVMe (QA Test Flow – 2/4)
Testing Dual-Port NVMe (QA Test Flow – 3/4)

- Example of Test Case (Simultaneous Write)
- Write to exclusive LBA address ranges using Port A and Port B simultaneously.
Testing Dual-Port NVMe (QA Test Flow– 3/4)

- Example Test Case (Simultaneous Read)
  - Read from the same LBA address range using both Port A and Port B
Testing Dual-Port NVMe
(QA Test Flow– 4/4)

• Checks if both ports can be accessed at the same time
• Checks if there is no performance degradation with simultaneous dual-port access
• Part of QA Test Flow
Conclusion

• Dual-port devices ensure redundancy and provides failover capability
• Provides ability to connect to two hosts simultaneously
• Used in Enterprise SSD market
• Current form factor is U.2
More Info: NVMe Dual-Port Testing

- Please visit us at Booth # 606 for to know more about NVMe Dual-Port Testing
Thanks