Standardized Storage Telemetry

Enabling Secure Fleet Monitoring and Debug

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Current Solutions for Monitoring and Debug

SMART
- Multiple standardized SMART pages
- No Vendor Unique (VU) SMART. All remaining fields are reserved and shall be 0h
- OCP Datacenter NVMe Specification* does not allow VU log pages outside of specification (SEC-19*) without prior written consent by the customer.

Telemetry
- Prior guidance (TEL-5*) was to use Data Area 1 for fleet monitoring but offered no payload guidance
- No guidance of Reason Identifier* payload

Security
- SEC-22* offers no guidance on what constitutes “Human Readable”

* OCP Datacenter NVMe SSD Specification v2.0, July 2021
New Standardized Telemetry Standard

Standardizes the NVMe® Telemetry Payloads in Data Area 1, Data Area 2 and Telemetry Reason Identifier

• Offers low latency / single command fleet monitoring
  • Data area 1
  • Incorporates data from other useful SMART pages
  • Additional standardized statistics supporting health monitoring and fleet balancing opportunities
  • Supports vendor unique statistics and event FIFO capabilities in a standardized way

• Offers a standardized debug method post panic
  • Data area 2
  • Reason Identifier (useful for segmentation)

• Offers a single, open-source OCP-NVMe-CLI decode generating human readable output
  • Includes Telemetry String Log for VU statistics and events

Example of standardized and VU extensible diagnostic and debug solution from automotive industry

Single command periodic fleet monitoring including VU details
Open industry standardized failure analysis with human readable output
Standardized Telemetry Overview

- Fleet Health Monitoring (Data Area 1)
- Fleet Drive Debug (Data Area 2)
- Physical Access to the drive
- VU Debug logs + data area 3/4

Issue Difficulty
- Standardized Human Readable Decode
- Not Decoded or VU Decode

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Standardized Telemetry Debug

Fleet Health Monitoring
Data Area 1

Fleet Drive Debug
Data Area 2
Reason Identifier

VU Debug
logs + data
area 3/4

Physical Access to
the drive

Issue Difficulty

Standardized Human Readable Decode

Not Decoded or VU Decode

OCP-NVMe-CLI Telemetry Plugin

VU String Decode Logpage

Human Readable

Datacenter Security Inspection

Vendor
Telemetry Layout Summary

Telemetry Header
Standardized Reason Identifier

Data Area 1 for Health Monitoring
NVMe® and OCP SMART+
Standardized and VU Telemetry Statistics+
VU Event FIFO(s)

Data Area 2 for Debug
VU Event FIFO(s)

Data Area 3

Data Area 4

Data Area 4 – Unconstrained Size
VU Crash Dumps

Legend:
Human Readable
Low IO Latency
High IO Latency
32MB per NVMe®
EDTAS
Specification Details
NVMe® Telemetry Log Page

Defined by the NVM Express™ Base Specification 2.0

Header indicates the size of the Data Areas
OCP Telemetry Log Page Format

- Header
- Data Area 1
- Data Area 2
- Data Area 3
- Data Area 4

OCP Header
- Statistics
- FIFO
- ...
- FIFO
- Zero Filled Padding

Header is relative to the start of the Data Area 1
OCP Telemetry Log Page Format

- **Header**
- **Data Area 1**
- **Data Area 2**
- **Data Area 3**
- **Data Area 4**

**OCP Header**
- Statistics
- FIFO
- ...
- FIFO
- Zero Filled Padding

**Version**
- Profile Information
- Statistics Information
- FIFO Information
- NVMe™ SMART / Health Information log page

**OCP SMART / Health Information Extended log page**
OCP Telemetry Log Page Format

- Header
- Data Area 1
- Data Area 2
- Data Area 3
- Data Area 4

OCP Header
- Statistics
- FIFO
- ... (repeated)
- FIFO
- Zero Filled Padding

Entry 0
Entry 1
...
Entry N

The # of Entries is Vendor Defined
OCP Telemetry Log Page Format

Header

Data Area 1

Data Area 2

Data Area 3

Data Area 4

OCP Header

Statistics

FIFO

FIFO

Zero Filled Padding

Entry 0

Entry 1

...

Entry N

Identifier

Persistence

Namespace

Data Size

Data

Identifier can specify an OCP defined Statistic or a Vendor defined Statistics
OCP Telemetry Log Page Format

- **Header**
- **Data Area 1**
- **Data Area 2**
- **Data Area 3**
- **Data Area 4**

**OCP Header**
- Statistics
- FIFO
- ...  
- FIFO
- Zero Filled Padding

**Entry 0**
- Persistence
- Namespace
- Data Size

**Entry 1**
- ...  

**Entry \(N\)**

Persistence indicates the behavior of the data due to resets.
OCP Telemetry Log Page Format

```
Header
Data Area 1
Data Area 2
Data Area 3
Data Area 4
```

```
OCP Header
Statistics
FIFO
FIFO
Zero Filled Padding
```

```
Entry 0
Entry 1
... 
Entry N
```

```
Identifier
Persistence
Namespace
Data Size
Data
```

Namespace indicates if the data is associated with a namespace and if so which one.
OCP Telemetry Log Page Format

<table>
<thead>
<tr>
<th>Header</th>
<th>OCP Header</th>
<th>Entry 0</th>
<th>Entry 1</th>
<th>...</th>
<th>Entry N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Area 1</td>
<td>Statistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Area 2</td>
<td>FIFO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Area 3</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Area 4</td>
<td>FIFO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zero Filled Padding</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Persistence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Namespace</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data size is dependent in the Identifier (i.e., variable sized entries)
OCP Telemetry Log Page Format

Header
Data Area 1
Data Area 2
Data Area 3
Data Area 4

OCP Header
Statistics
FIFO
...
FIFO
Zero Filled Padding

Entry 0: Oldest
Entry 1
...
Entry $N$: Newest

The # of Entries is Vendor Defined
OCP Telemetry Log Page Format

- **Header**
- **Data Area 1**
- **Data Area 2**
- **Data Area 3**
- **Data Area 4**

**OCP Header**
- Statistics
- FIFO
- ... (FIFO)
- Zero Filled Padding

**Debug Type** is a classification (e.g., NVMe™, PCIe®, Resets, Vendor Specific)

**Entry 0: Oldest**
**Entry 1**
... (Entry N : Newest)

**Debug Type**
- Identifier
- Data Size
- Data
- Vendor Identifier
- Vendor Data
OCP Telemetry Log Page Format

**Header**
- Data Area 1
- Data Area 2
- Data Area 3
- Data Area 4

**OCP Header**
- Statistics
  - FIFO
  - ... (Zero Filled Padding)

**Debug Type**
- Data Size
- Data
- Vendor Identifier
- Vendor Data

**Entry**
- Entry 0: Oldest
- Entry 1
- ... (Zero Filled Padding)
- Entry N: Newest

**Identifier within the Class**
(i.e., OCP Defined or Vendor Specific)
OCP Telemetry Log Page Format

Data Area 1
- Header
- OCP Header
- Statistics
- FIFO
- FIFO
- Zero Filled Padding
- Entry 0: Oldest
- Entry 1
- ... (FIFO pattern)
- Entry N : Newest
- Data
- Data Size
- Debug Type
- Identifier
- Vendor Identifier
- Vendor Data

Data is the data Identifier within the Class (i.e., OCP Defined or Vendor Specific)
OCP Telemetry Log Page Format

Vendor Identifier and Vendor Data is optional additional vendor specific information for an OCP define Debug Type.
OCP Telemetry Log Page Format

- **Header**
- **Data Area 1**
- **Data Area 2**
- **Data Area 3**
- **Data Area 4**

**OCP Header**
- **Statistics**
- **FIFO**
- **…**
- **FIFO**
- **Zero Filled Padding**

Relative to the start of the Data Area 1
Relative to the start of the Data Area 2
Generating Human Readable Strings

Parse the Telemetry log page and for each Statistics or Event print:

- The data
- The ASCII string definition
  
  - Hard code standards defined text
  
  - Lookup Vendor defined text in the OCP Strings log page
OCP Strings Log Page

- **Header**
- **Vendor Specific Statistics Identifier String Table**
- **Vendor Specific Event Identifier String Table**
- **OCP Event Vendor Specific Identifier String Table**
- **ASCII Strings**

**Identifier**
- **Length**
- **Offset**

**Entry 0: Smallest ID**
- **Entry 1**
- **...**
- **Entry N: Largest ID**

Relative to the start of log page

Relative to the start of the ASCII Strings

ASCII text for the VU Identifier
OCP Strings Log Page

Header

Vendor Specific Statistics Identifier String Table

Vendor Specific Event Identifier String Table

OCP Event Vendor Specific Identifier String Table

ASCII Strings

Entry 0: Smallest ID
Entry 1
...
Entry N: Largest ID

Debug Type
Identifier
Length
Offset

Relative to the start of the ASCII Strings
OCP Strings Log Page

<table>
<thead>
<tr>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Specific Statistics Identifier String Table</td>
</tr>
<tr>
<td>Vendor Specific Event Identifier String Table</td>
</tr>
<tr>
<td>OCP Event Vendor Specific Identifier String Table</td>
</tr>
<tr>
<td>ASCII Strings</td>
</tr>
</tbody>
</table>

| Debug Type |
| Identifier |
| Length |
| Offset |

- Entry 0: Smallest ID
- Entry 1
- ... (omitted)
- Entry \(N\): Largest ID

Relative to the start of the ASCII Strings
Please take a moment to rate this session.

Your feedback is important to us.