



Metrics and Telemetry in Swordfish

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Abstract: This paper defines the approach, infrastructure and mechanisms to use for Swordfish implementations, to capture and store historical metrics to present to Swordfish clients in a standardized fashion, using the Redfish telemetry service.

SNIA White Paper

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USAGE

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Current Revision

SNIA is actively engaged in expanding and refining the Swordfish documentation. The most current revision can be found on the SNIA web site at https://www.snia.org/tech_activities/standards/curr_standards/swordfish.

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Revision History

The evolution of this document is summarized in Table 1.

Table 1: Revision History

Date	Rev	Notes
12 April 2022	1.2.4	Initial version; Release as Working Draft
12 July 2022	1.2.4a	Release as SNIA Standard.
16 March 2023	1.2.5	Release as Working Draft
20 June 2023	1.2.5a	Release as SNIA Standard
22 January 2024	1.2.6	Release as Working Draft
9 April 2024	1.2.6	Release as SNIA Standard

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Acknowledgements

The SNIA Scalable Storage Management Technical Work Group, which developed and reviewed this white paper, would like to recognize the significant contributions made by the following members listed in Table 2.

Table 2: Contributors

Member	Representatives (* – prior employer)
Intel Corporation	Richelle Ahlvers

Executive Summary

This paper defines the approach, infrastructure and mechanisms to use for Swordfish implementations, to capture and store historical metrics to present to Swordfish clients in a standardized fashion, using the Redfish telemetry service.

Using capacity metrics use cases, we will highlight the expected standard usage of the telemetry service to enable standard client interactions across implementations. We will also provide guidance for expected base functionality, as well as describing how the implementations can provide additional value-add capability accessible to the clients.

1 Management Demands Metrics

Storage management clients rely on detailed, historical information in several areas of the overall system to watch for issues, perform diagnostics and system reconfigurations, provide data for billing and usage forecasting, and other actions.

Some storage-specific areas of interest are performance analysis and capacity utilization trend analysis. Analysis of both of these areas generally requires ongoing data trend analysis, provided over time by historical data logging of specific attributes and values. Note: While systems can provide a single “point-in-time” representation of these attributes, we are referring here to the need for more advanced data representation and analysis. The mechanism to provide collection, storage, and presentation of such information within the Redfish and Swordfish ecosystem is the telemetry service.

2 Telemetry Model

2.1 Overview

The Redfish telemetry service provides the instantiation of the Redfish telemetry model. It includes multiple components; we will focus on the metrics (MetricDefinitions, MetricReportDefinitions, and MetricReports) for the purposes of this paper.

The interactions of interest, and basic dependencies, in the telemetry service with properties in Redfish/Swordfish objects are shown in Figure 1.

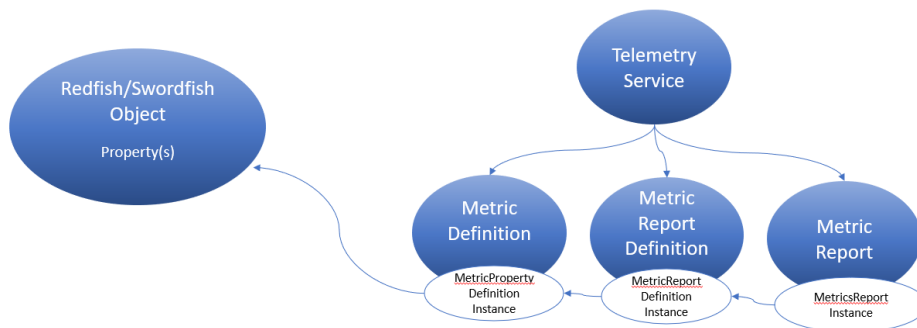


Figure 1: Using the telemetry service to manage metrics

For a more detailed overview of the Redfish telemetry model, you can review the “Redfish Telemetry White Paper” (DSP2051). It will provide a general overview of the model, as well as the properties of each component in the model. [https://www.dmtf.org/sites/default/files/standards/documents/DSP2051_1.0.0.pdf]

2.2 MetricDefinitions

The data retrieved from a Redfish/Swordfish object is discrete, point in time, observations. A metric is defined as a time series, trend of data, with the capability of combining multiple discrete points of data into a richer set of available information.

For a property (or set of properties) of interest, there will be a corresponding MetricDefinition. There may be more than one MetricDefinition that points to a given property or set of properties, using different calculations or analyses.

The MetricDefinition provides context around the properties that metrics refer to, building a framework for developing any analysis or context for the data. A Met-

`MetricDefinition` contains references to the properties it relates to, as well as information about the appropriate type and description of calculations for these properties, any data manipulation required (e.g., data offset, calibration), the data type, min and max values, and additional similar descriptive attributes. It also contains pointers to any, or every, occurrence of the property or set of properties in the system.

The `MetricDefinition` can be thought of having two sections:

- Header - contains all of the supporting property definitions
- Location - contains the `Wildcards` and `MetricProperties` definitions, which provide information about properties and their specific referenced locations in the system

The following `MetricDefinition` provides a sample usage for a Capacity Metric.

Sample `MetricDefinition`:

The set of properties defined in the metric definition itself includes only those properties that describe the metric. For simple metrics such as the capacity metric in this example, this simply includes a small set of properties describing the metric type, units, and context.

```
{
  "@odata.type":
    ↪ "#MetricDefinition.v1_1_0.MetricDefinition",
  "Id": "AllocatedBytes",
  "Name": "Allocated Bytes Metric Definition",
  "MetricType": "Numeric",
  "MetricDataType": "Integer",
  "LogicalContexts": ["Capacity", "Storage"],
  "Units": "Bytes"
}
```

The wildcards section has multiple purposes. This usage reflects the base implementation requirements. Refer to the value-add requirements section for additional usage capabilities. Using the `Name` property (only) in conjunction with the `MetricProperties` section below defines the scope of the metric definition to apply to all instances of the metric within the Swordfish model.

```
{
  "Wildcards": [{
    "Name": "SystemID"
  }],
}
```

```
{
  "Name": "StorageSystemID"
},
{
  "Name": "SystemStoragePoolID"
},
{
  "Name": "SystemVolumeID"
},
{
  "Name": "StorageID"
},
{
  "Name": "StoragePoolID"
},
{
  "Name": "VolumeID"
},
{
  "Name": "FileSystemID"
}
]
}
```

The `MetricProperties` section contains URI pointers to all potential locations in the system. The wildcards above are uniquely used in conjunction with these URI constructs to identify all of the potential locations for properties to which this metric type can apply, throughout the Redfish and Swordfish schema.

As noted in this example, the Swordfish templates will generally include all possible metric value locations as part of the base functionality. Implementations may choose to implement additional capabilities within the constraints already provided in the telemetry service to allow clients to restrict the application of the metric to subsets of the system.

```
{
  "MetricProperties": [
    "/redfish/v1/Systems/{SystemID}/Storage/{SystemStorageID}/StoragePools/
```

```

    {SystemStorage-
  ↪ PoolID}/AllocatedVolumes/{SystemVolumeID}/Capacity#/
    Data/AllocatedBytes",
"/red-
  ↪ fish/v1/Storage/{StorageID}/StoragePools/{StoragePoolID}/
    AllocatedVol-
  ↪ umes/{VolumeID}/Capacity#/Data/AllocatedBytes",
"/red-
  ↪ fish/v1/StorageServices/{StorageServiceID}/StoragePools/
    {ServiceStorage-
  ↪ PoolID}/AllocatedVolumes/{ServiceVolumeID}/
    Capacity#/Data/AllocatedBytes",
"/red-
  ↪ fish/v1/Storage/{StorageID}/FileSystems/{FileSystemID}/
    Capacity#/Data/AllocatedBytes",
"/red-
  ↪ fish/v1/Systems/{SystemID}/Storage/{SystemStorageID}/
    FileSys-
  ↪ tems/{SystemFileSystemID}/Capacity#/Data/AllocatedBytes",
"/red-
  ↪ fish/v1/StorageServices/{StorageServiceID}/FileSystems/
    {ServiceFileSystemID}/Capacity#/Data/AllocatedBytes",
"/red-
  ↪ fish/v1/Storage/{StorageID}/FileSystems/{FileSystemID}/
    RemainingCapacity#/Data/AllocatedBytes",
"/red-
  ↪ fish/v1/Systems/{SystemID}/Storage/{SystemStorageID}/
    FileSys-
  ↪ tems/{SystemFileSystemID}/RemainingCapacity#/Data/AllocatedBytes",
"/red-
  ↪ fish/v1/StorageServices/{StorageServiceID}/FileSystems/
    {ServiceFileSys-
  ↪ temID}/RemainingCapacity#/Data/AllocatedBytes"
],
"@odata.id":
  ↪ "/redfish/v1/TelemetryService/MetricDefinitions/
    AllocatedBytes",

```

```
"@Redfish.Copyright": "Copyright 2014-2022 SNIA. All  
  ↪ rights reserved."  
}
```

2.3 MetricReportDefinitions

A `MetricReportDefinition` builds on a `MetricDefinition`, providing information and additional constraints in order to generate the metric reports themselves. These include specifying the frequency (and type) of data collection, metric calculation properties, information on, and reporting mechanisms with properties including metric logs specific to the metric. These can also include additional scope constraints above those specified in the metric definition.

The `MetricReportDefinition` can also be thought of having two sections:

- Header - contains all of the supporting property definitions
- Location - contains the `Wildcards` and `MetricProperties` definitions, which provide additional information and context about specific referenced locations in the system

The following `MetricReportDefinition` provides a sample usage for a capacity metric report.

The properties included in the `MetricReportDefinition` specify the scheduling parameters for gathering the metrics, including frequency and periodicity. They also include properties to specify what to do with the output: e.g., send as events, or send to logs. If logged, it includes where to log, and additional properties regarding log management.

```
{  
  "@odata.type": "#MetricReportDefini-  
  ↪ tion.v1_3_0.MetricReportDefinition",  
  "Id": "TotalAllocatedCapacity",  
  "Name": "Total Allocated Capacity",  
  "MetricReportDefinitionType": "Periodic",  
  "MetricReportDefinitionEnabled": true,  
  "Schedule": {  
    "RecurrenceInterval": "PT1H"  
  },  
  "ReportActions": [  
    "LogToMetricReportsCollection"  
  ]  
}
```

```
  ],
  "ReportUpdates": "NewReport",
  "MetricReport": {
    "@odata.id":
      ↪ "/redfish/v1/TelemetryService/MetricReports/
        TotalAllocatedCapacity"
  },
  "Status": {
    "State": "Enabled"
  }
}
```

As with the underlying metric definitions, the metric report definitions also include information about the scope of the system to target.

For the Swordfish templates, this scope will largely be identical to that of the underlying metric, covering the entire system. Implementations may choose to support customization here as well, both within individual metric reports, as well as supporting multiple metric reports against the same metrics with different scope, time intervals, report actions (destinations), or other properties varied.

```
{
  "Wildcards": [{
    "Name": "SystemID"
  },
  {
    "Name": "StorageSystemID"
  },
  {
    "Name": "SystemStoragePoolID"
  },
  {
    "Name": "SystemVolumeID"
  },
  {
    "Name": "StorageID"
  },
  {
    "Name": "StoragePoolID"
  },
  },
}
```

```

    {
      "Name": "VolumeID"
    },
    {
      "Name": "FileSystemID"
    }
  ]
}

```

The `Metrics` section of the report definition includes both pointers to the metrics in scope, as well as information about the data collection that needs to be done on each report generation cycle.

In this example, the data collection will be done once an hour, and the value at that point is of interest (e.g., no calculation of multiple sampled data across the hour is necessary; a simple data point collection will suffice).

```

{
  "Metrics": [
    {
      "MetricId": "AllocatedCapacity",
      "MetricProperties": [
        "/red-
        ↪ fish/v1/Systems/{SystemID}/Storage/{SystemStorageID}/
        ↪ StoragePools/{SystemStoragePoolID}/AllocatedVolumes/
        ↪ {SystemVolumeID}/Capacity#/Data/AllocatedBytes",
        "/red-
        ↪ fish/v1/Storage/{StorageID}/StoragePools/{StoragePoolID}/
        ↪ AllocatedVolumes/{VolumeID}/Capacity#/Data/AllocatedBytes",
        "/red-
        ↪ fish/v1/StorageServices/{StorageServiceID}/StoragePools/
        ↪ {ServiceStoragePoolID}/AllocatedVolumes/{ServiceVolumeID}
        ↪ /Capacity#/Data/AllocatedBytes",
        "/red-
        ↪ fish/v1/Storage/{StorageID}/FileSystems/{FileSystemID}
        ↪ /Capacity#/Data/AllocatedBytes",

```

```

        "/red-
        ↪ fish/v1/Systems/{SystemID}/Storage/{SystemStorageID}
        ↪ /FileSystems/{SystemFileSystemID}/Capacity#/Data/
           AllocatedBytes",
        "/red-
        ↪ fish/v1/StorageServices/{StorageServiceID}/FileSystems
           /{ServiceFileSys-
        ↪ temID}/Capacity#/Data/AllocatedBytes",
        "/red-
        ↪ fish/v1/Storage/{StorageID}/FileSystems/{FileSystemID}
           /RemainingCapacity#/Data/AllocatedBytes",
        "/red-
        ↪ fish/v1/Systems/{SystemID}/Storage/{SystemStorageID}/
           FileSys-
        ↪ tems/{SystemFileSystemID}/RemainingCapacity#/Data/
           AllocatedBytes",
        "/red-
        ↪ fish/v1/StorageServices/{StorageServiceID}/FileSystems/
           {ServiceFileSys-
        ↪ temID}/RemainingCapacity#/Data/AllocatedBytes"
    ],
    "CollectionFunction": "Maximum",
    "CollectionTimeScope": "Point",
    "CollectionDuration": "PT1H"
  }
],
"@odata.id": "/red-
  ↪ fish/v1/TelemetryService/MetricReportDefinitions/
  TotalAllocatedCapacity",
"@Redfish.Copyright": "Copyright 2014-2022 SNIA. All
  ↪ rights reserved."
}

```

2.4 Metric Reports

MetricReports are the output: they contain the output records, as specified in the corresponding MetricReportDefinition. These can be from a single run,

or a series over time, depending on the properties set in the `MetricReportDefinition`.

Metrics can also be set to be sent via Redfish Events; reporting via events is not covered in detail in this white paper.

The following `MetricReport` shows a sample output for a Capacity Metric.

```
{
  "@odata.type": "#MetricReport.v1_4_2.MetricReport",
  "Id": "TotalAllocatedCapacity",
  "Name": "Total Allocated Capacity Performance Metric
  ↪ Report",
  "ReportSequence": "18",
  "MetricReportDefinition": {
    "@odata.id": "/red-
    ↪ fish/v1/TelemetryService/MetricReportDefinitions/
      TotalAllocatedCapacity"
  },
  "MetricValues": [
    {
      "MetricId": "TotalAllocatedCapacity",
      "MetricValue": "300067890136",
      "Timestamp": "2021-04-29T12:25:00-05:00",
      "MetricProperty":
        ↪ "/redfish/v1/Systems/Sys-1/Storage/
          DirectAttachStorageSys-
          ↪ tem/Volumes/Volume1/Capacity#/Data/
            AllocatedBytes"
    },
    {
      "MetricId": "TotalAllocatedCapacity",
      "MetricValue": "300067890136",
      "Timestamp": "2021-04-29T12:25:00-05:00",
      "MetricProperty":
        ↪ "/redfish/v1/Systems/Sys-1/Storage/
          DirectAttachStorageSys-
          ↪ tem/Volumes/Volume1/Capacity#/Data/
            AllocatedBytes"
    },
  ],
}
```

```
{
  "MetricId": "TotalAllocatedCapacity",
  "MetricValue": "300067890136",
  "Timestamp": "2021-04-29T12:25:00-05:00",
  "MetricProperty":
    ↪ "/redfish/v1/Systems/Sys-1/Storage/
      DirectAttachStorageSys-
↪ tem/Volumes/Volume1/Capacity#/Data/
      AllocatedBytes"
},
{
  "MetricId": "TotalAllocatedCapacity",
  "MetricValue": "300067890136",
  "Timestamp": "2021-04-29T12:30:00-05:00",
  "MetricProperty":
    ↪ "/redfish/v1/Systems/Sys-1/Storage/
      DirectAttachStorageSys-
↪ tem/Volumes/Volume1/Capacity#/Data/
      AllocatedBytes"
},
{
  "MetricId": "TotalAllocatedCapacity",
  "MetricValue": "300067890136",
  "Timestamp": "2021-04-29T12:35:00-05:00",
  "MetricProperty":
    ↪ "/redfish/v1/Systems/Sys-1/Storage/
      DirectAttachStorageSys-
↪ tem/Volumes/Volume1/Capacity#/Data/
      AllocatedBytes"
},
{
  "MetricId": "TotalAllocatedCapacity",
  "MetricValue": "300067890136",
  "Timestamp": "2021-04-29T12:40:00-05:00",
  "MetricProperty":
    ↪ "/redfish/v1/Systems/Sys-1/Storage/
      DirectAttachStorageSys-
↪ tem/Volumes/Volume1/Capacity#/Data/
```

```
        AllocatedBytes"
    }
],
"@odata.id":
    ↪ "/redfish/v1/TelemetryService/MetricReports/
    TotalAllocatedCapacity",
"@Redfish.Copyright": "Copyright 2014-2022 SNIA. All
    ↪ rights reserved."
}
```

3 Metrics and Telemetry Within Swordfish

3.1 Mechanisms for Resource Identification

There are three different permutations for determining the scope of applicability of the metrics or metrics definition.

1. Provide references to locations using the `Wildcards` property in conjunction with the URIs specified in the Metrics (`MetricProperties` or `Metric` fields) using no explicitly named instances; this definition means that all instances in each location are in scope.

This mechanism is provided out-of-the-box, and balances between requiring the management of large data set storage and configuration scalability/volatility issues (e.g., changing configuration due to data protection functionality, or other applications causing dynamic file/volume/object reconfiguration).

2. Using a combination of the reference mechanism specified in #1, but add instances to reduce / focus the scope using the addition of the `Name` property within the `Wildcards` section. This will filter the application of the scope to only the objects specifically named for each specific Wildcard reference in the URI.

This mechanism is preferred for implementations, particularly large implementations, as it provides the clients a balance of the out-of-the-box configuration provided above, with functionality available to all objects, but with the ability to apply more specifically to their known configuration. It balances the ability to automatically applies all metrics to all instances with the ability to supports scalability and volatile configurations (e.g., use of dynamic provisioning).

3. Do not use the `Wildcard` reference section, and explicitly reference the instances desired in the `Metric` section.

This model is the most inflexible, and from a client perspective, does not work well for large, dynamic configurations. Explicit references require a significant amount of manual management, and will have issues with scalability and volatility of the configuration. This approach is only suitable for small, static configurations.

While implementations may choose to support an explicit reference model, it would not be compatible with the Swordfish templates, which follow the model specified in #1 above.

3.2 Value-add Customization

The Swordfish templates, provided as part of the Swordfish bundle, follow the model for resource identification specified above to identify every potential instance of the defined property throughout their implementation, and, as the default, support the metric report to be run as-is against these.

Implementations may want to support additional client customization on top of this base functionality. This may include the type of customization described above in the “Mechanisms for Resource Identification” section to support more targeted application of the metric reports, filtering the application to only those objects of interest.

Opportunities for value-add customization may also involve allowing clients to customize in other ways, such as supporting more frequent reporting, additional notification mechanisms (e.g., `RedfishEvents`), or adding additional customized metrics, report definitions, and reports to the standard set, as well as allowing clients to create their own. All of these may be supported without relying on OEM extensions.

For More Information

More information about Swordfish and the SNIA Scalable Storage Mananagment API can be found at <http://www.snia.org/swordfish>.