

STORAGE DEVELOPER CONFERENCE



*BY Developers FOR Developers*

# Comprehensive SNIA Swordfish® Overview

Richelle Ahlvers, Storage Technology Enablement  
Architect, Intel  
Chair, SNIA SSM TWG and Storage Management Initiative

# Abstract

- SNIA Swordfish® provides a comprehensive standards-based interface to manage scalable storage. This presentation provides a broad look at the Swordfish ReSTful hierarchies, maps these to some common applications, and provides an overview of the Swordfish tools and documentation ecosystem developed by SNIA's Scalable Storage Management Technical Work Group (SSM TWG).
- It will also provide an overview added in the 1.2.5a release, including enhancements to metrics for volumes, drives, and storage controllers, as well as support for NVMe SMART Metrics, enhanced NVMe-oF discovery controller capabilities managing NVMe-oF centralized discovery controllers.
- The presentation will also provide pointers to get started working with Swordfish, as well as information on related programs, including the Swordfish Conformance Test Program.

# About the Presenter



## **Richelle Ahlvers**

Storage Technology  
Enablement Architect, Intel

Richelle is a Storage Technology Enablement Architect at Intel, where she promotes and drives enablement of new technologies and standards strategies. Richelle has spent over 25 years in Enterprise R&D teams in a variety of technical roles, leading the architecture, design and development of storage array software, storage management software user experience projects including mobility, developing new storage industry categories including SAN management, storage grid and cloud, and storage technology portfolio solutions.

Richelle has been engaged with industry standards initiatives for many years and is actively engaged with many groups supporting manageability including SNIA, DMTF, NVMe, OFA and UClE. She is Vice-Chair of the SNIA Board of Directors, Chair of the Storage Management Initiative, leads the SSM Technical Work Group developing the Swordfish Scalable Storage Management API, and has also served as the SNIA Technical Council Chair and been engaged across a breadth of technologies ranging from storage management, to solid state storage, to cloud, to green storage. She also serves on the DMTF Board of Directors as the VP of Finance and Treasurer.

# What are Redfish and Swordfish?

DMTF Redfish™ covers server, data center, basic fabric management

- REST API with JSON payloads; choice of CSDL, JSON and YAML schema for development

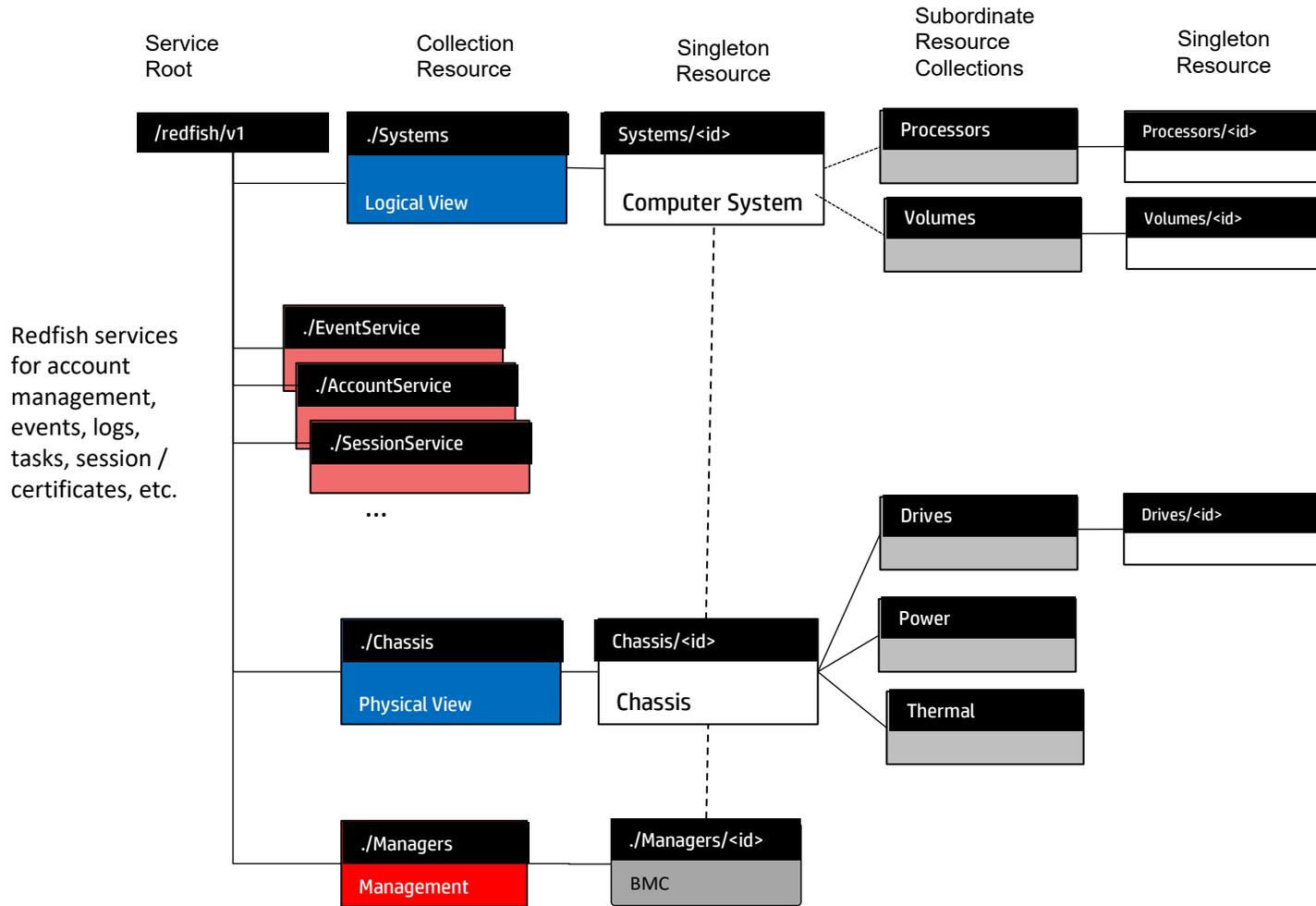
SNIA Swordfish™: Storage Management Specification with REST Based API extends DMTF's Redfish Specification

Swordfish adds storage management to all of these use cases, plus storage fabric management

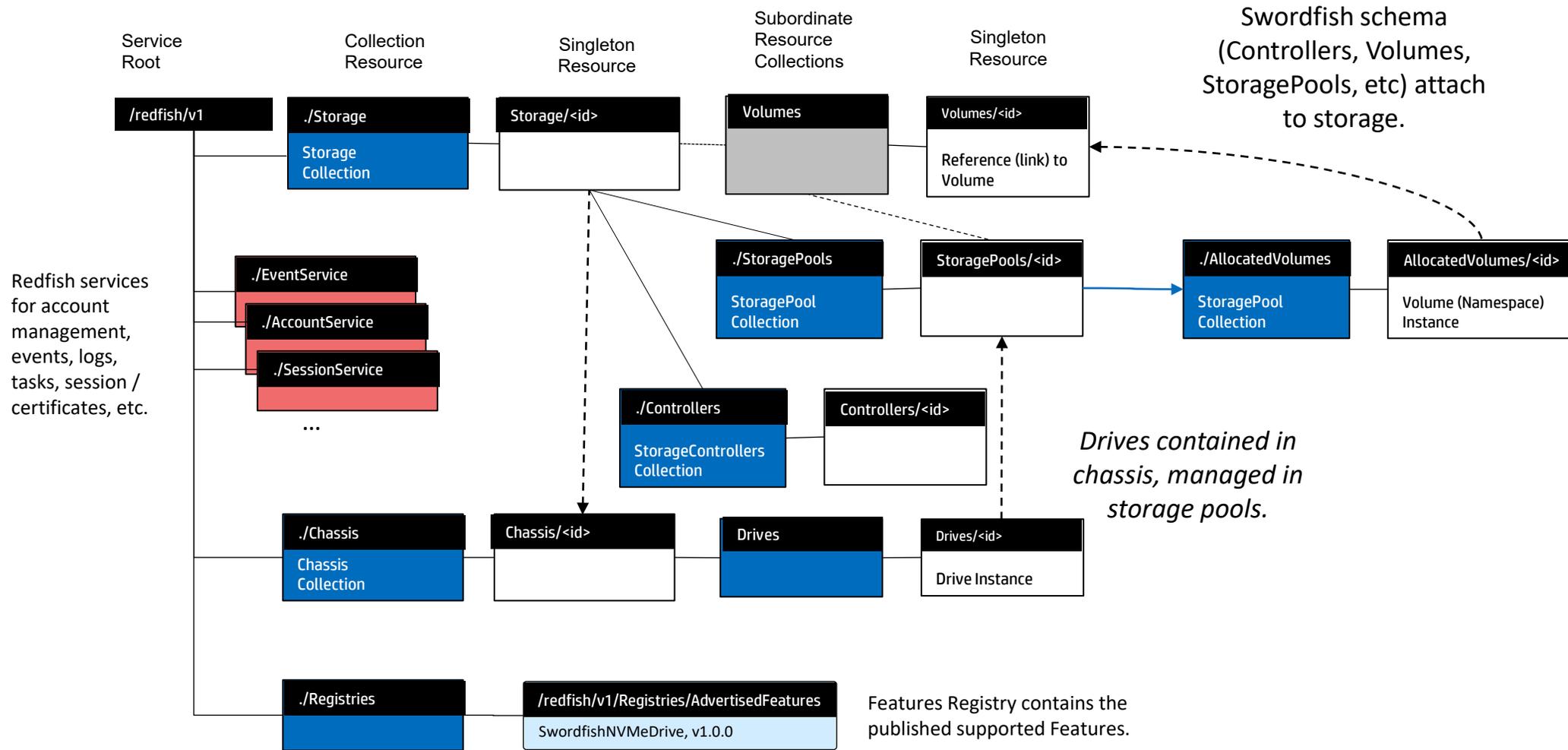
- Covers block, file, and object storage
- Extend traditional storage domain coverage to include converged environments (servers, storage and fabric together)
- Provides the option for implementation to utilize Class of Service (intent or service level) based provisioning, management, and monitoring
- NVMe / NVMe-oF devices (through an Alliance partnership with NVM Express® and DMTF)
- Storage Fabric Management: An alliance partnership with OFA, DMTF is expanding support in RF/SF for fabrics and storage fabrics management in OFA Sunfish™



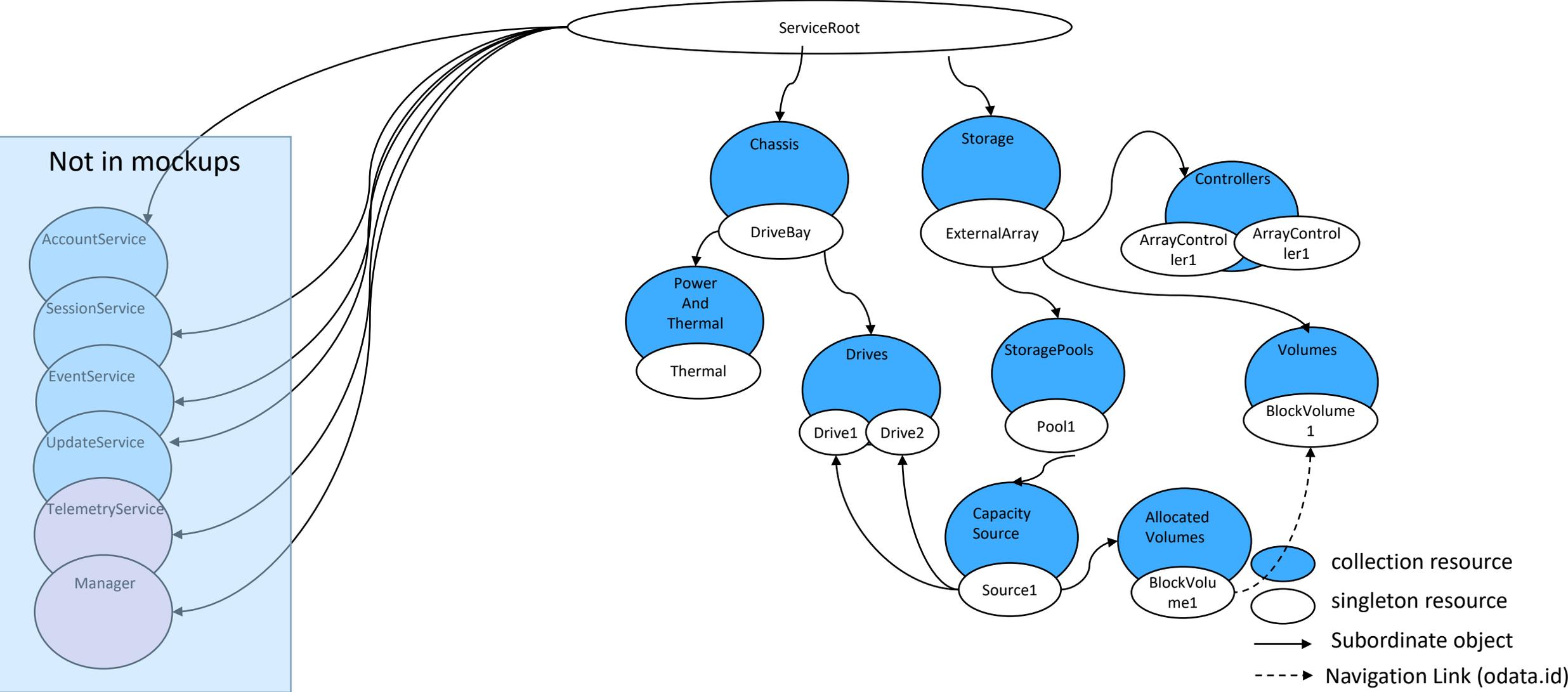
# Basic Redfish Hierarchy



# Building on the Redfish Hierarchical for Swordfish Advanced Storage



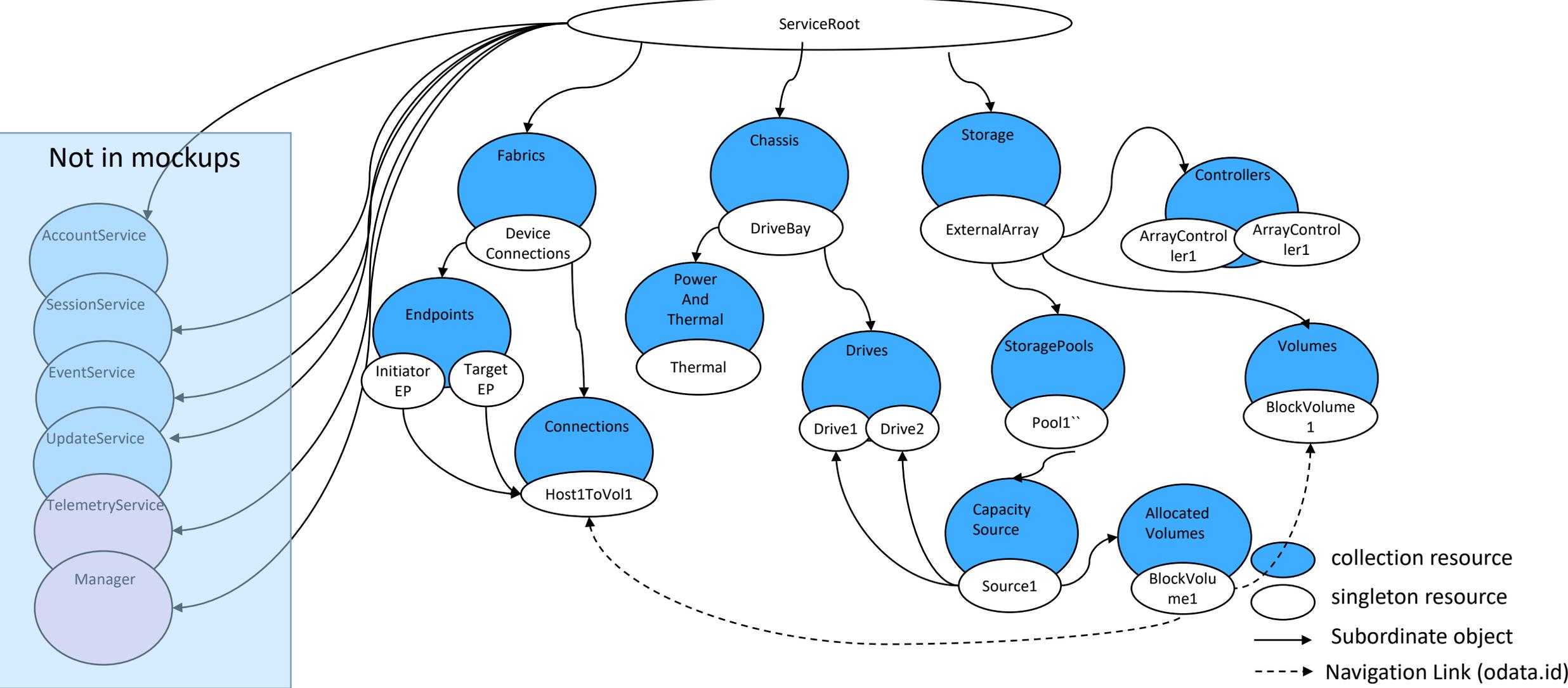
# Simple External Array (The Basics)



**Not in mockups**

- AccountService
- SessionService
- EventService
- UpdateService
- TelemetryService
- Manager

# Simple External Array (Adding Mapping)



# NVMe Functionality

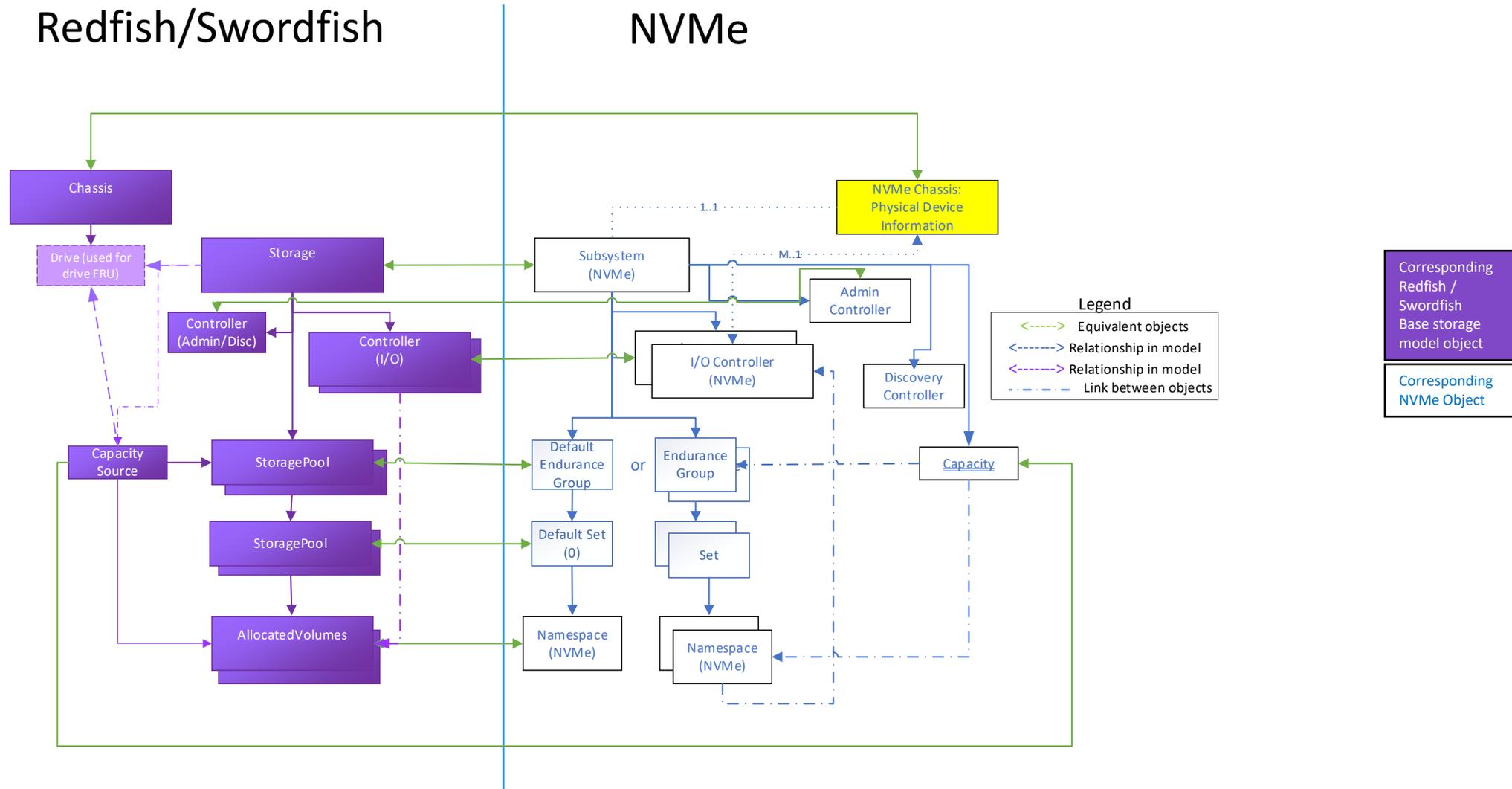
## Swordfish maps NVMe objects to existing RF/SF model

- NVM Subsystem
- NVM Controllers (IO, admin, discovery)
- Namespaces
- Endurance groups
- NVM Sets

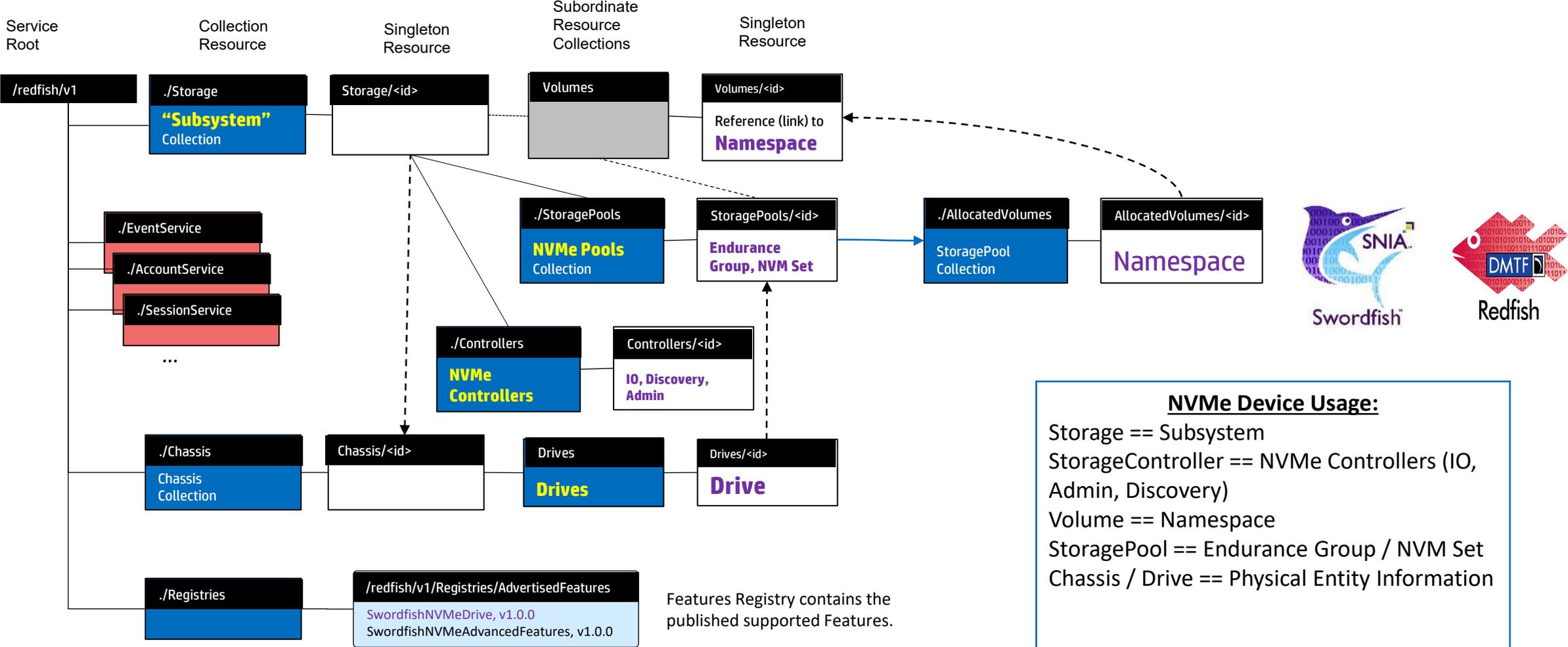
## Creates new objects where needed

- NVMe Domains

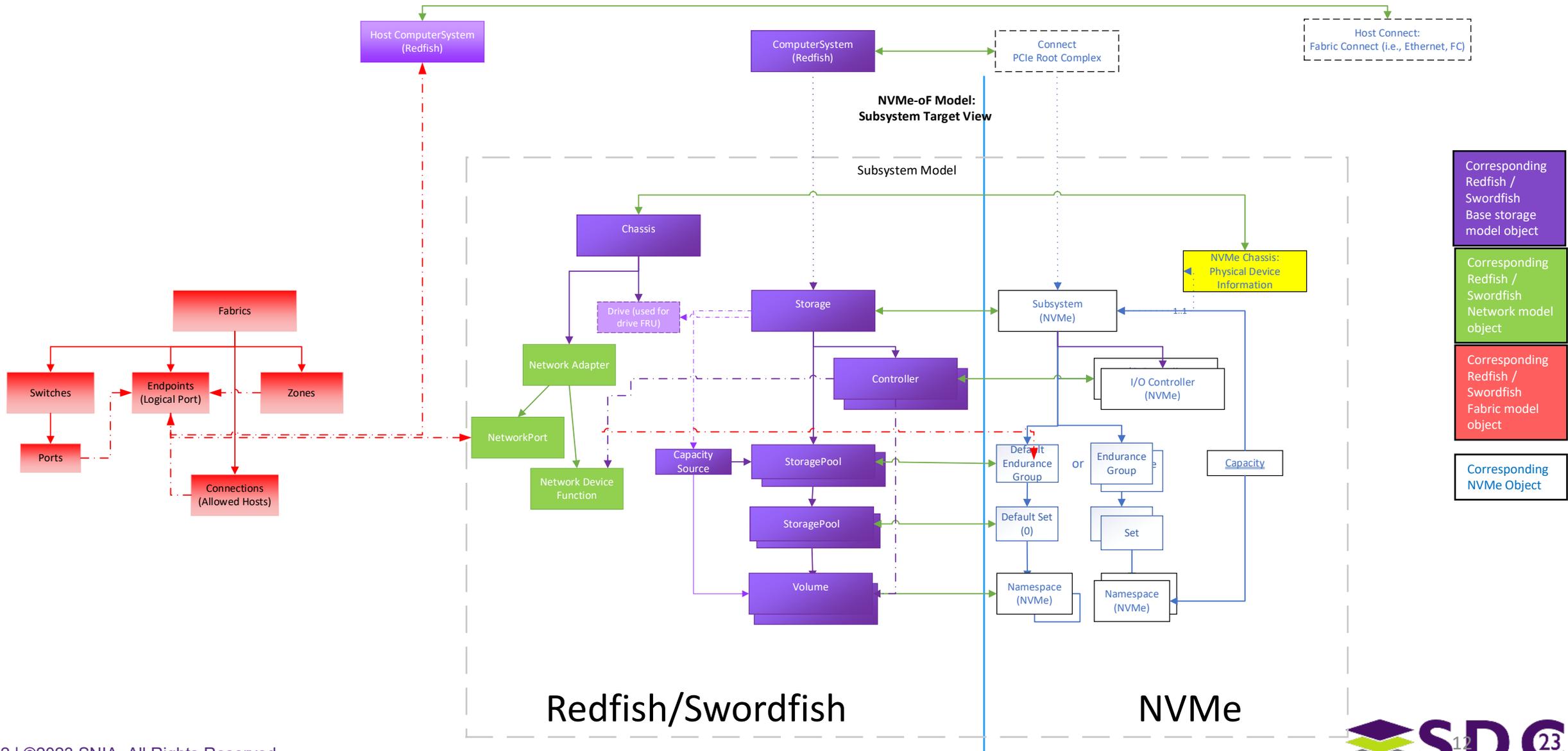
# NVMe Subsystem Model



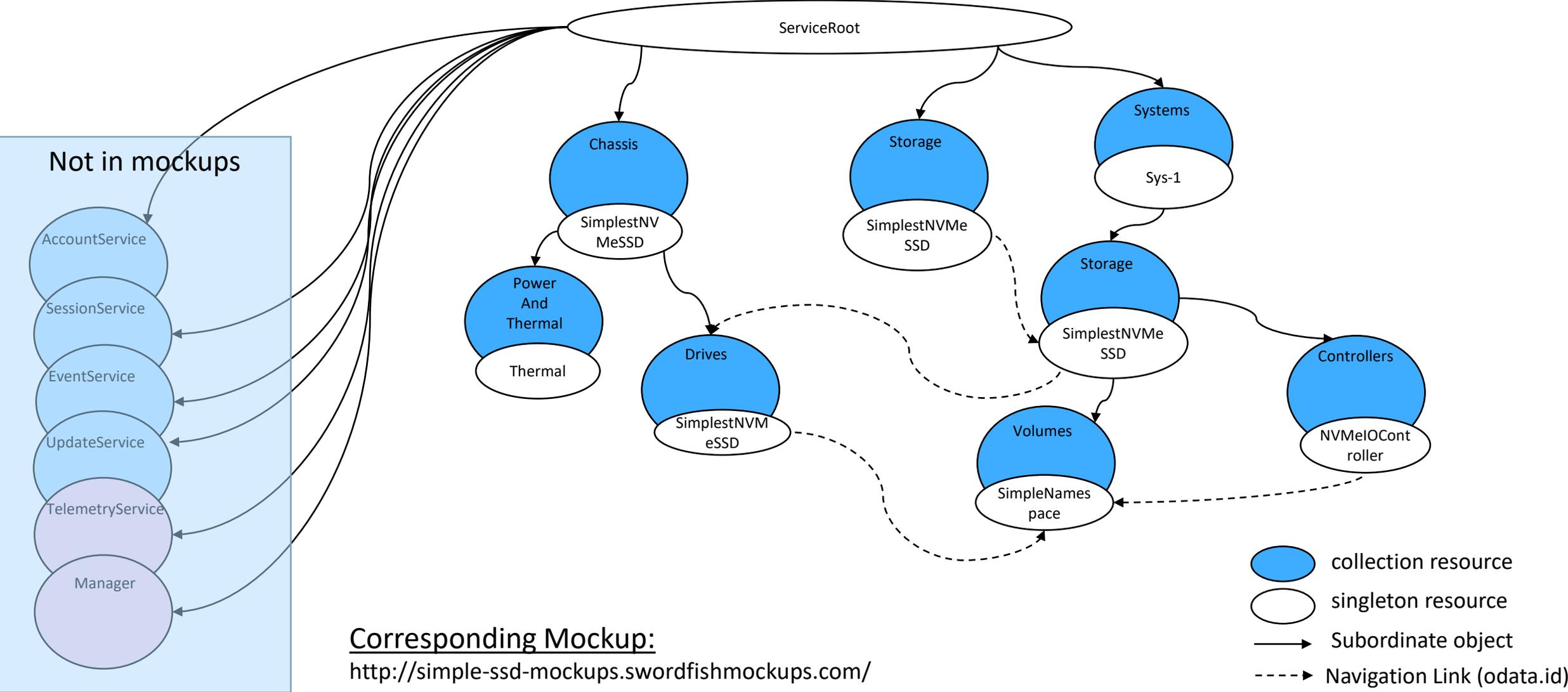
# Swordfish and NVMe: Basic Functionality



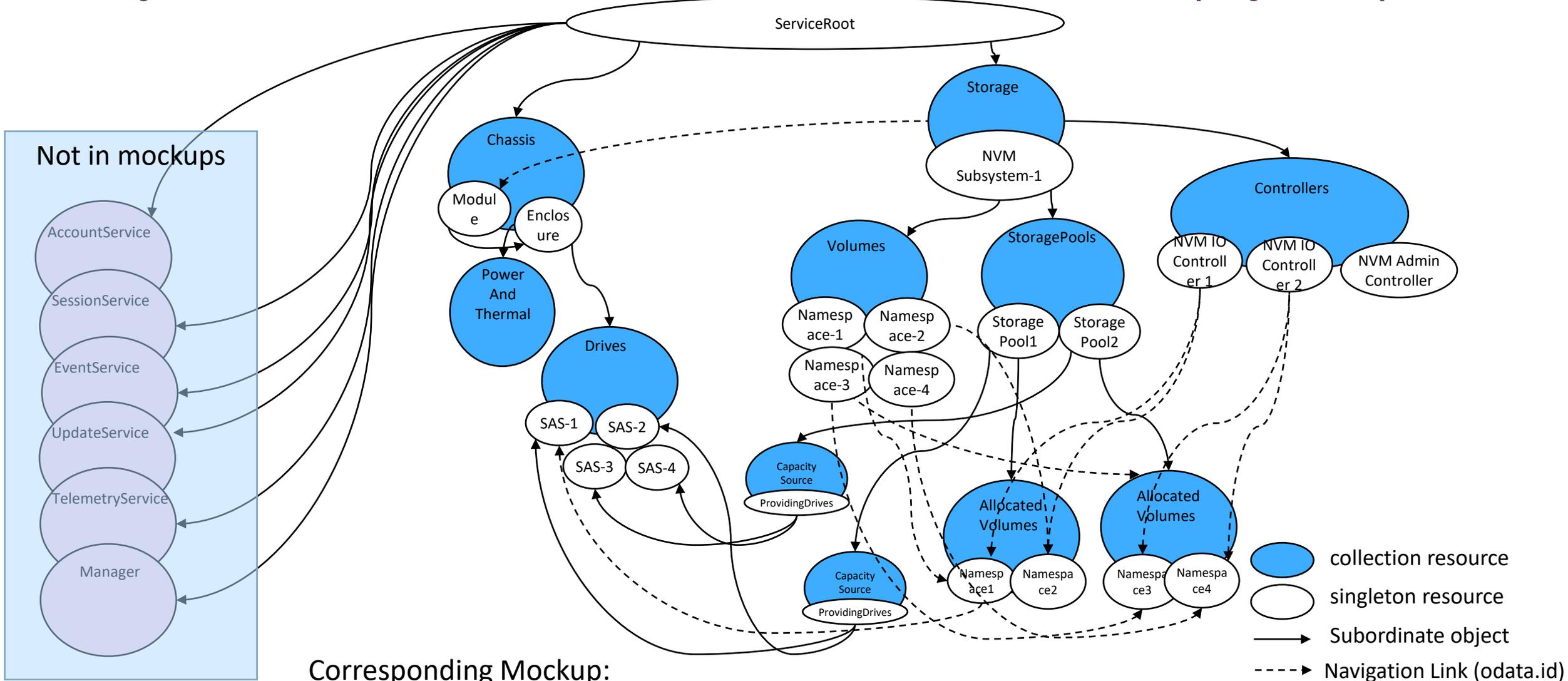
# Adding Network and Fabric...



# Simple NVMe Drive



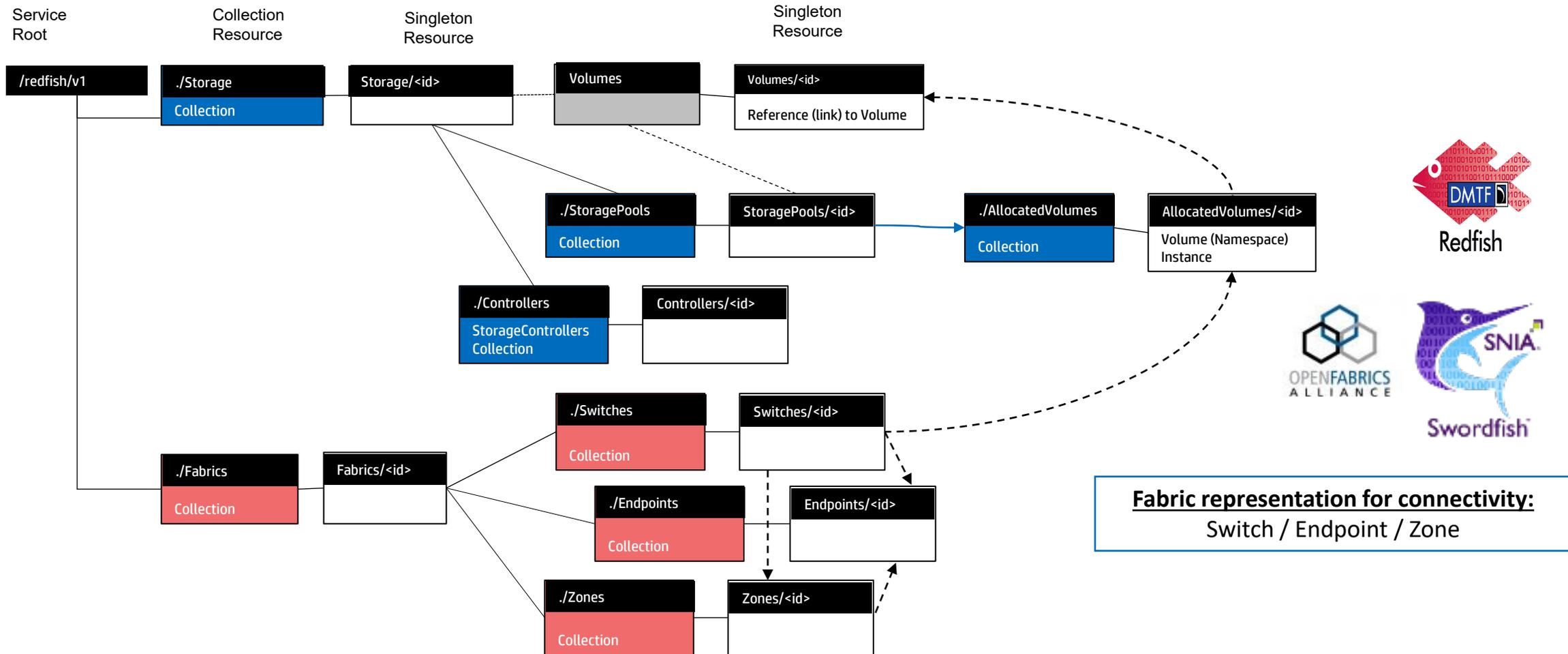
# Array with NVMe Front-end, SAS Backend (Hybrid)



**Corresponding Mockup:**

<http://nvme-opaque-array-mockups.swordfishmockups.com/>

# Redfish/Swordfish Hierarchy: Managing Extended Connectivity

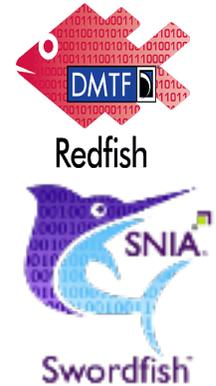
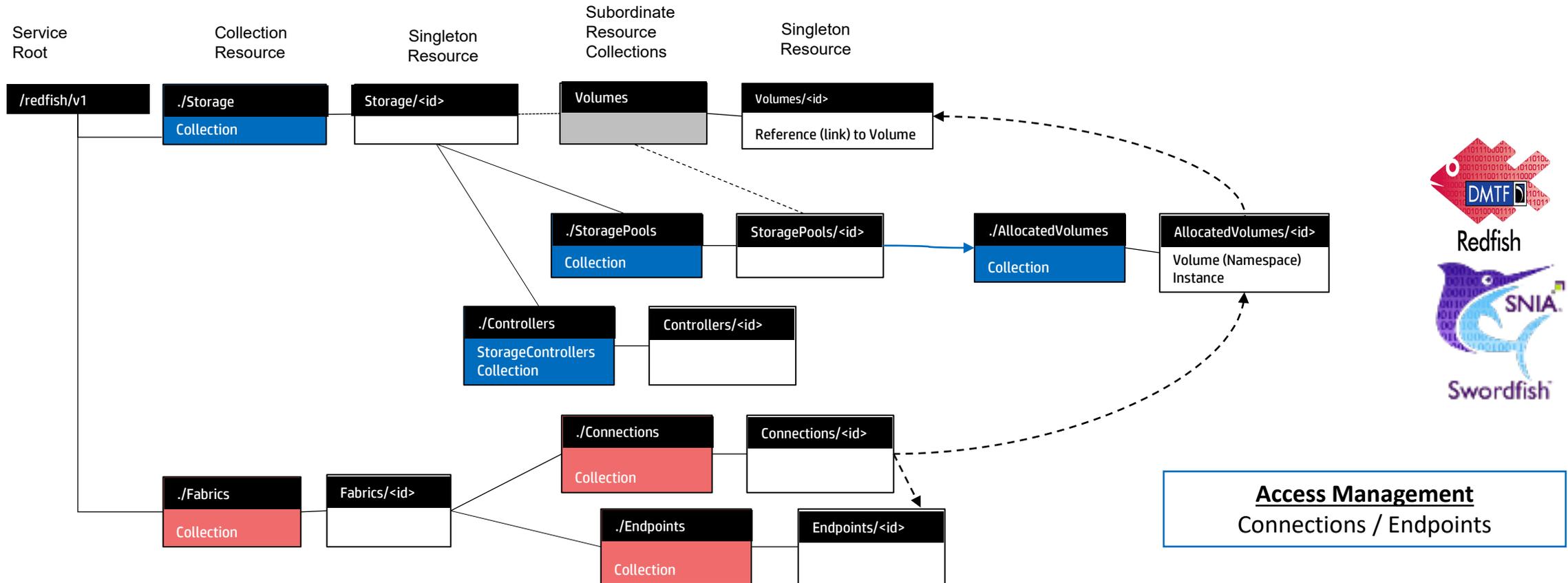


Redfish

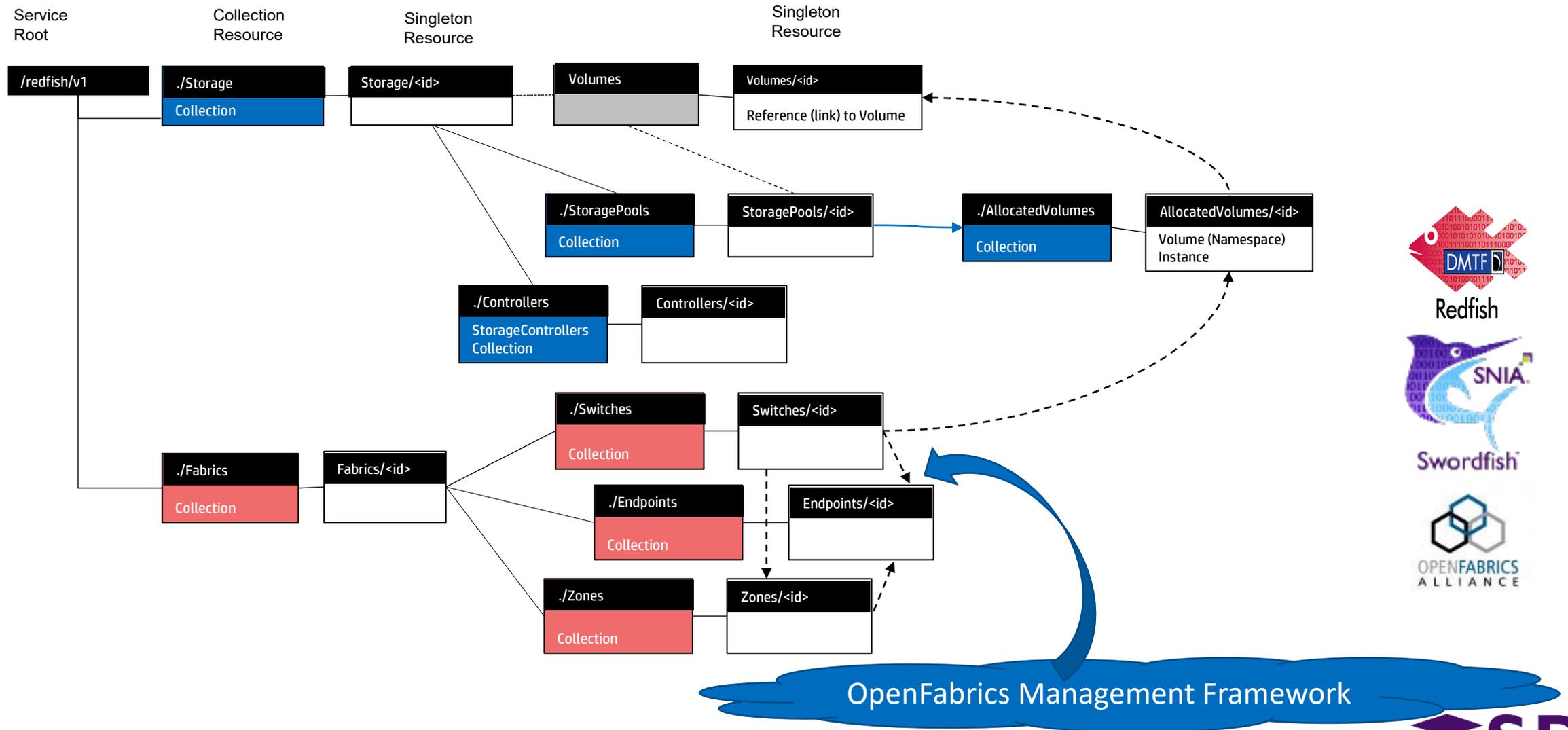


Swordfish

# Redfish/Swordfish Hierarchy: Adding Multi-System Access Management



# Developing the OpenFabrics Framework and Mapping to Redfish and Swordfish



Redfish



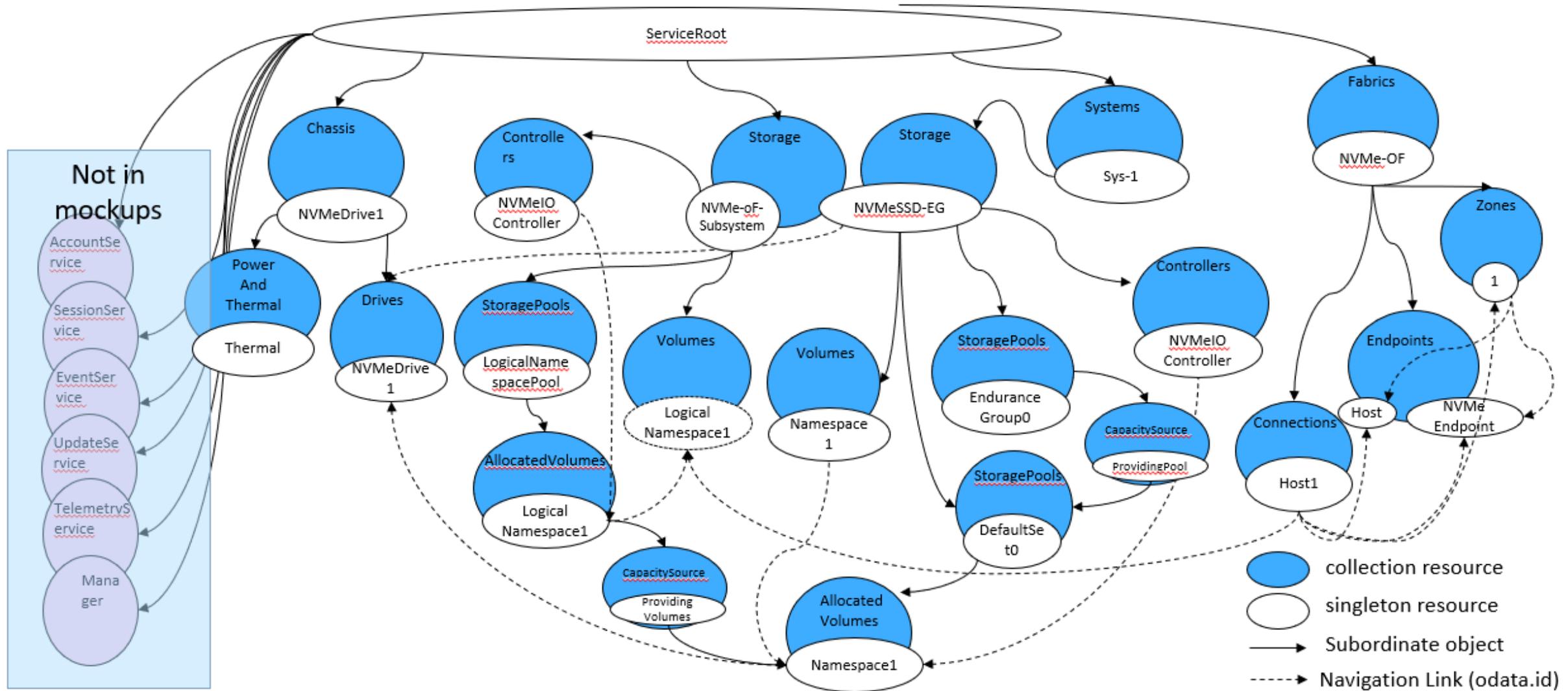
Swordfish



OpenFabrics Management Framework



# Sample NVMe-oF Instance



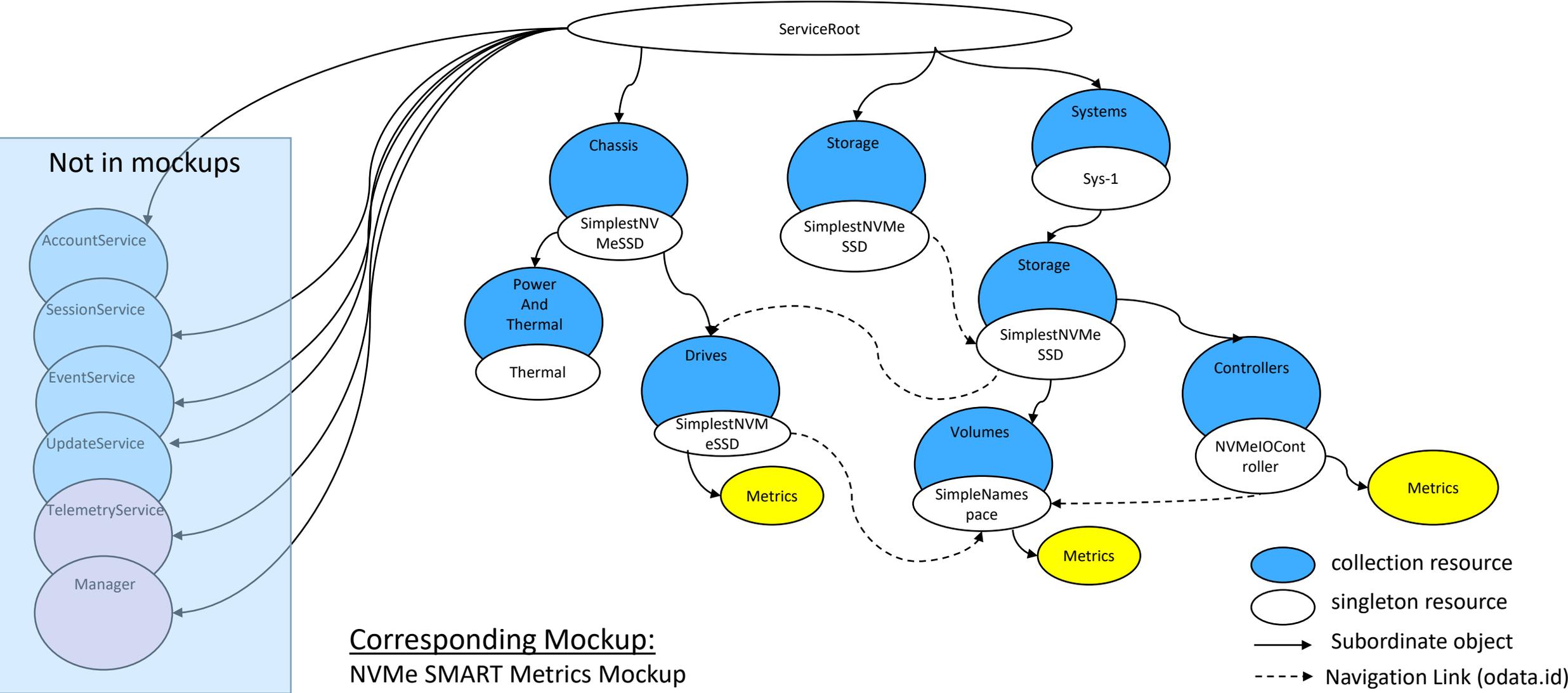
# What's New in 1.2.5a



## ■ Expanding Functionality

- NVMe and NVMe-oF mapping expanded to align with NVMe 2.0c
  - Support for NVMe Smart Metrics
  - Management of centralized discovery controllers
- Metrics for Volumes, Drives, and Storage Controllers
- Enhanced mapping and masking model

# Adding Metrics



# StorageControllerMetrics contains NVMeSmartMetrics

```
{
"@odata.type": "#StorageControllerMetrics.v1_0_0.StorageControllerMetrics",
"Name": "Storage Controller Metrics for NVMe IO Controller",
"Id": "Metrics",
"NVMeSMART": {
  "CriticalWarnings": {
    "PMRUnreliable": false,
    "PowerBackupFailed": false,
    "MediaInReadOnly": false,
    "OverallSubsystemDegraded": false,
    "SpareCapacityWornOut": false
  },
  "CompositeTemperatureCelsius": 308,
  "AvailableSparePercent": 50,
  "AvailableSpareThresholdPercent": 30,
  "PercentageUsed": 50,
  "EGCriticalWarningSummary": {
    "NamespacesInReadOnlyMode": false,
    "ReliabilityDegraded": false,
    "SpareCapacityUnderThreshold": false
  },
  "DataUnitsRead": 0,
  "DataUnitsWritten": 0,
  "HostReadCommands": 0,
  "HostWriteCommands": 0,
  "ControllerBusyTimeMinutes": 20,
  "PowerCycles": 49,
```

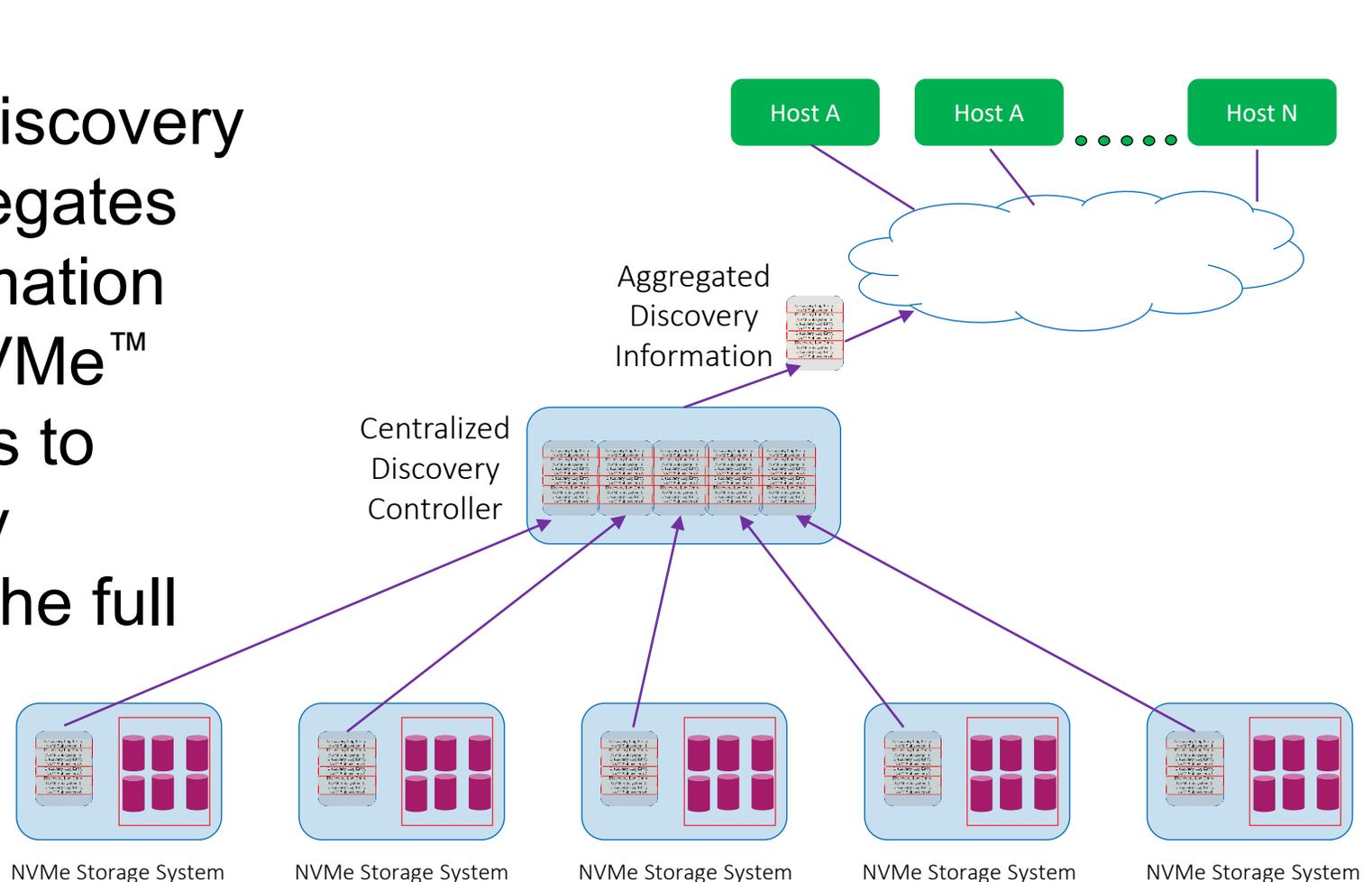
```
  "PowerOnHours": 3,
  "UnsafeShutdowns": 4,
  "MediaAndDataIntegrityErrors": 0,
  "NumberOfErrorInformationLogEntries": 100,
  "WarningCompositeTempTimeMinutes": 0,
  "CriticalCompositeTempTimeMinutes": 0,
  "TemperatureSensorsCelsius": [
    308,
    308,
    308,
    300,
    305,
    309,
    307,
    306
  ],
  "ThermalMgmtTemp1TransitionCount": 10,
  "ThermalMgmtTemp2TransitionCount": 2,
  "ThermalMgmtTemp1TotalTimeSeconds": 20,
  "ThermalMgmtTemp2TotalTimeSeconds": 42
},
"Oem": {
},
"@odata.id": "/redfish/v1/Systems/Sys-1/Storage/SimplestNVMeSSD/Controllers/NVMeIOController/Metrics",
"@Redfish.Copyright": "Copyright 2015-2023 SNIA. All rights reserved."
}
```

See example here:

<https://simple-ssd-smart-metrics-mockups.swordfishmockups.com/redfish/v1/Systems/Sys-1/Storage/SimplestNVMeSSD/Controllers/NVMeIOController/Metrics>

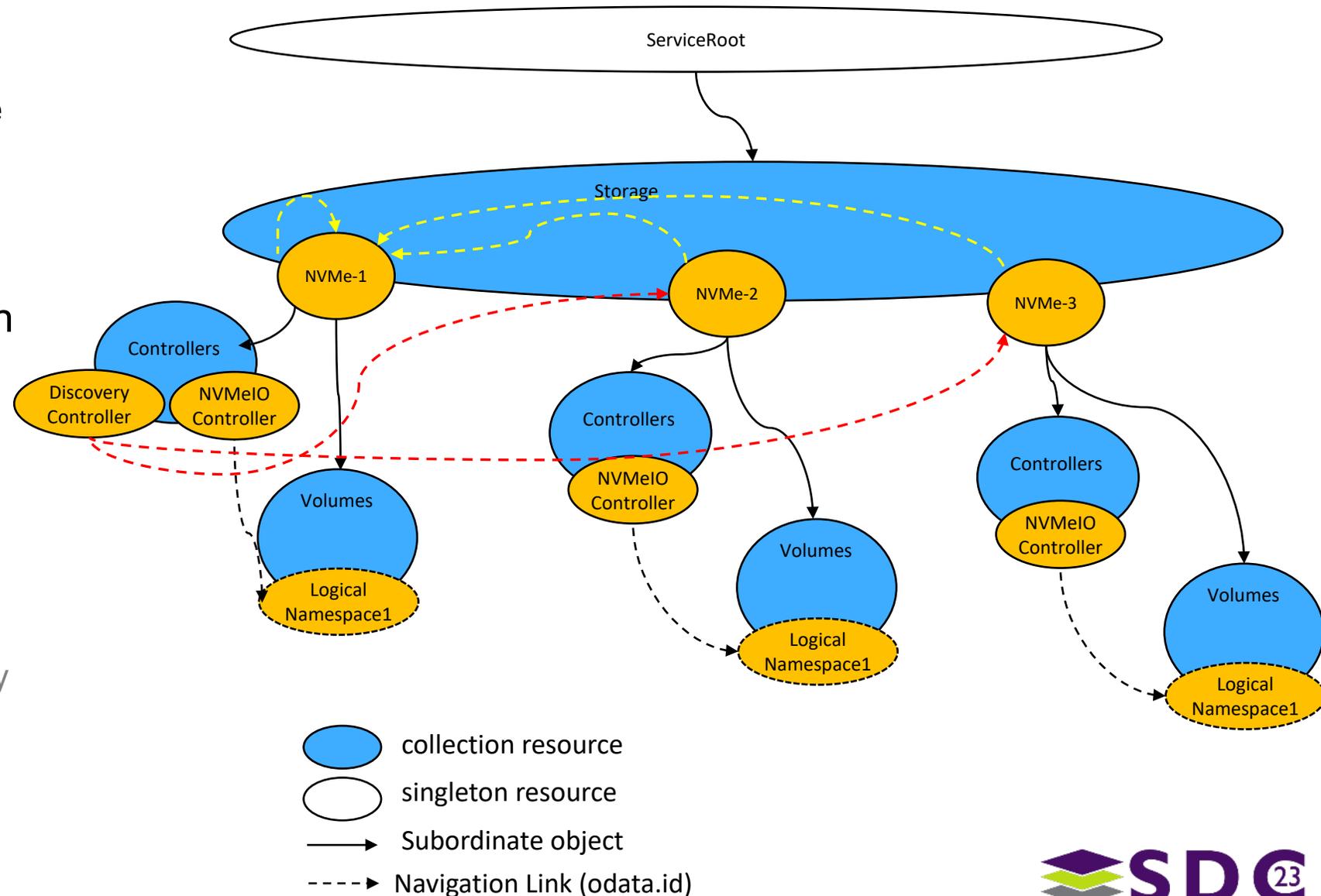
# Centralized Discovery Controller

- A Centralized Discovery Controller aggregates discovery information from several NVMe™ storage systems to report discovery information for the full fabric.



# Swordfish Representation of Discovery Controllers

- Discovery Controllers require no configuration by the end user / client.
- So, we have created an extremely simplified, read-only model with information in two places:
  - Subsystems.
    - Subsystems have pointers to subsystems which contain discovery controllers
  - Discovery Controllers.
    - Discovery controllers have pointers to the subsystems they have discovered



# Mockup of Subsystem

```
> nvme-ebof-mockups
> nvme-jbof-mockups
> nvme-opaque-array-mockups
> nvme-tcp-array-mockups
v nvmeof-discovery-controller-mockups
  > $metadata
  > Chassis
  > Fabrics
  > Registries
  > SessionService
  v Storage
    v NVMeoF-Discovery
      > Controllers
        index.json
      v NVMeoF-SS1
        > Controllers
        > StoragePools
        > Volumes
        index.json
    > NVMeoF-SS2
      index.json
    > StorageSystems
    > Systems
      index.json
  > nvmeof-mockups
  > nvmeof-RDMA-mockup
  > service-based-mockups
  > simple-ssd-capabilities-mockups
  > simple-ssd-eg-set-mockups
  > simple-ssd-mockups
node_modules
profiles
RDE-dictionaries
registries
> ...

1  {
2  "@odata.id": "/redfish/v1/Storage/NVMeoF-SS1",
3  "@odata.type": "#Storage.v1_15_0.Storage",
4  "Id": "1",
5  "Name": "NVMe-oF Logical NVM Fabric System",
6  "Description": "An NVM Express Subsystem is an NVMe device that contains one or more NVM Express
7  controllers and may contain one or more namespaces.",
8  "Status": {
9    "State": "Enabled",
10   "Health": "OK",
11   "HealthRollup": "OK"
12 },
13 "Identifiers": [{
14   "DurableNameFormat": "NQN",
15   "DurableName": "nqn.2014-08.org.nvmexpress:uuid:6c5fe566-10e6-4fb6-aad4-8b4159f50245"
16 }],
17 "Controllers": {
18   "@odata.id": "/redfish/v1/Storage/NVMeoF-SS1/Controllers"
19 },
20 "Volumes": {
21   "@odata.id": "/redfish/v1/Storage/NVMeoF-SS1/Volumes"
22 },
23 "Links": {
24   "NVMeoFDiscoverySubsystems": [{
25     "@odata.id": "/redfish/v1/Storage/NVMeoF-Discovery"
26   }]
27 },
28 "@odata.id": "/redfish/v1/Storage/NVMeoF-SS1",
"@Redfish.Copyright": "Copyright 2015-2022 SNIA. All rights reserved."
```

# Mockup of Discovery Controller

```
19  ],
20
21  "NVMeControllerProperties": {
22    "NVMeVersion": "1.3",
23    "NVMeControllerAttributes": {
24      "ReportsUUIDList": false,
25      "SupportsSQAssociations": false,
26      "ReportsNamespaceGranularity": false,
27      "SupportsTrafficBasedKeepAlive": false,
28      "SupportsPredictableLatencyMode": false,
29      "SupportsEnduranceGroups": false,
30      "SupportsReadRecoveryLevels": false,
31      "SupportsNVMSets": false,
32      "SupportsExceedingPowerOfNonOperationalState": false,
33      "Supports128BitHostId": false
34    },
35    "DiscoveredSubsystems": [{
36      "@odata.id": "/redfish/v1/Storage/NVMeoF-SS1"
37    },
38    {
39      "@odata.id": "/redfish/v1/Storage/NVMeoF-SS2"
40    }
41  ]
42  },
43  "Links": {
44    "Endpoints": [{
```

# How to Demonstrate Conformance to Swordfish

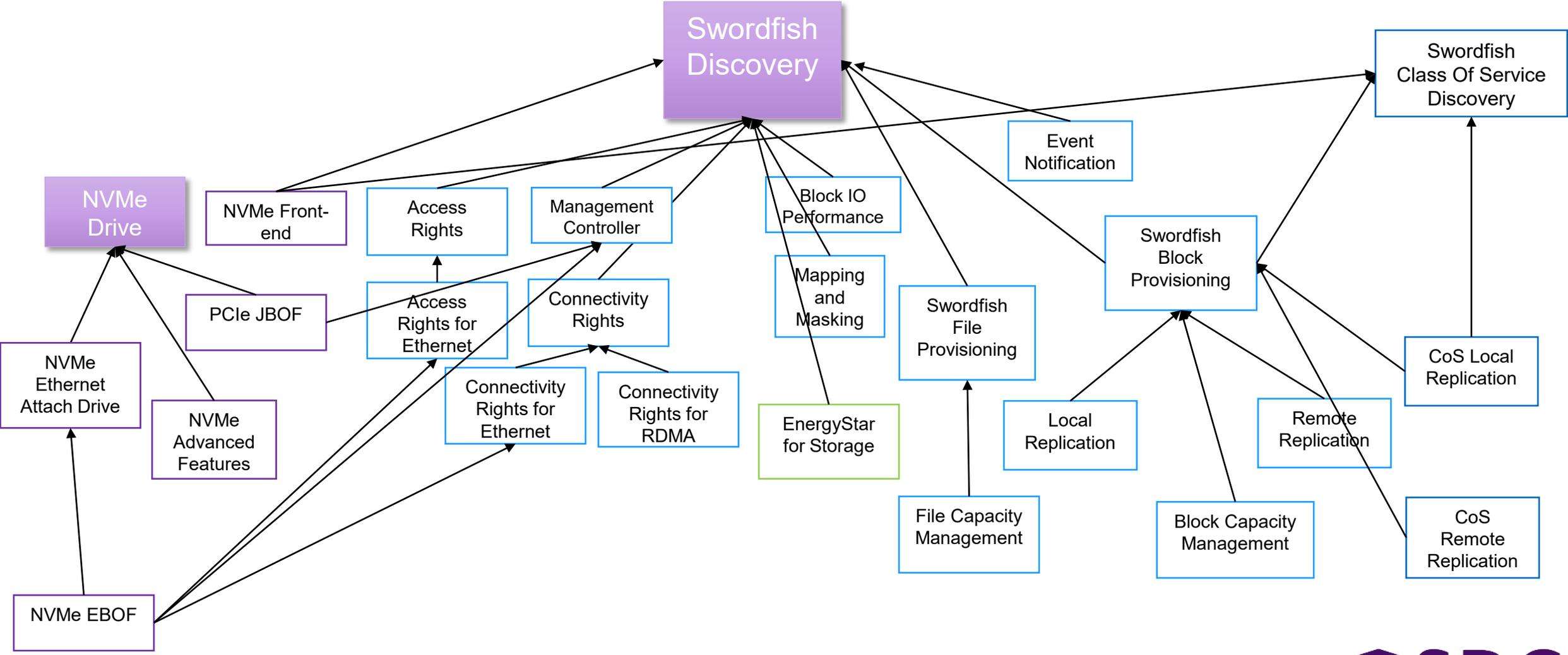
# In the Service: Implement the Features Registry

- What are Features (or Supported Features)?
  - Descriptions of functionality that an implementation is advertising that it supports.
  - This corresponds to a detailed list of behaviors and properties defined in a profile

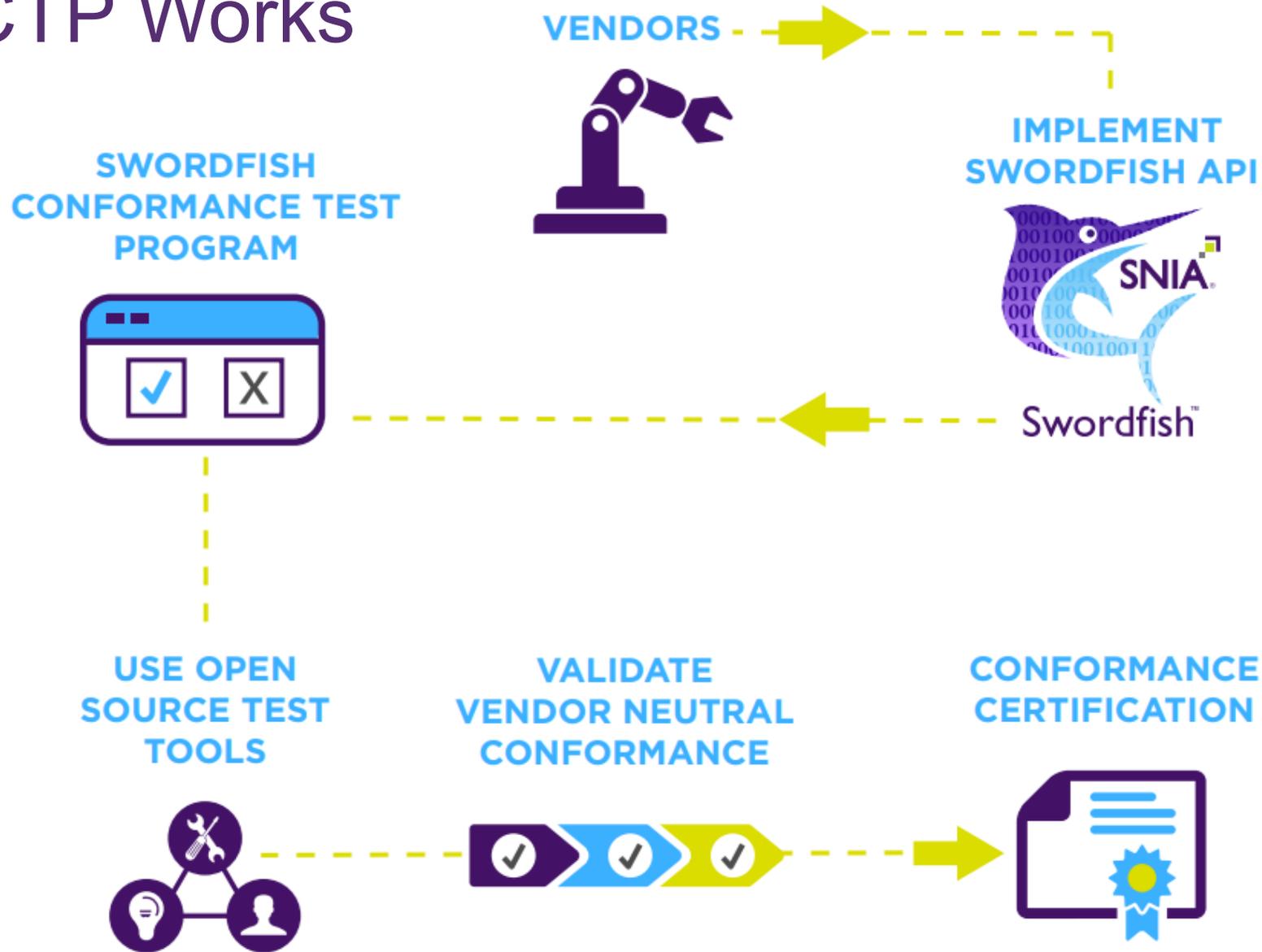
```
{
  "@odata.type": "#FeaturesRegistry.v1_1_1.FeaturesRegistry",
  "Id": "AdvertisedFeatures.v1_0_0",
  "Name": "Global Swordfish Features Registry",
  "Language": "en",
  "RegistryPrefix": "SwordfishFeaturesRegistry",
  "RegistryVersion": "1.5.0",
  "OwningEntity": "SNIA",
  "Features": [
    {
      "FeatureName": "SNIA.Swordfish.NVMeDrive",
      "Description": "Supports the Swordfish NVMe Drive Feature.",
      "Version": "1.2.0",
      "CorrespondingProfileDefinition": "SwordfishNVMeDrive.v1_2_0.json"
    }
  ]
}
```

[https://simple-ssd-mockups.swordfishmockups.com/redfish/v1/Registries/AdvertisedFeatures.v1\\_0\\_0.json](https://simple-ssd-mockups.swordfishmockups.com/redfish/v1/Registries/AdvertisedFeatures.v1_0_0.json)

# Swordfish Features/Profiles Inheritance Hierarchy

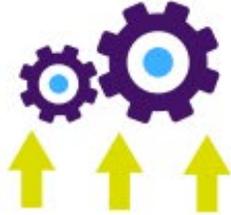


# How CTP Works



# Why Do SNIA Swordfish CTP?

**INCREASES  
INTEROPERABILITY**



**MEETS NEED OF  
STANDARDS-BASED SOLUTIONS**



**CONFORMS TO  
INDUSTRY STANDARDS**



**ENABLES VENDOR  
CHOICE FREEDOM**



**REDUCES  
INTEGRATION COSTS**

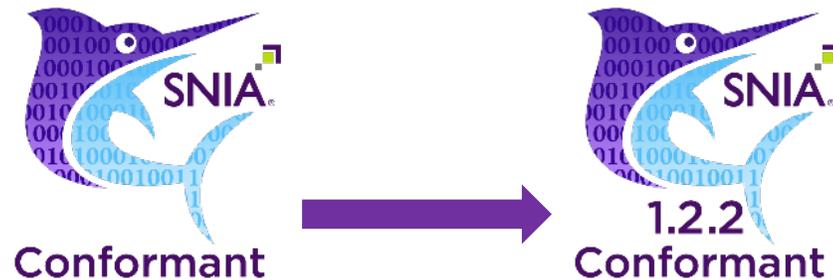


**LOWERS COST OF  
OWNERSHIP**



# CTP Logo and Version

- The CTP Program logos are numbered to correspond to the versions of Swordfish that the SSM TWG chooses to release as SNIA Standards
  - Easy for clients to match your implementations with specifications
  - Identifiable logos to use in marketing materials



# Framework and Test Overview

# Test Framework

- The test framework leverages the “Redfish-Test-Framework”, an open source framework from the Redfish Forum
  - No need to learn complex setup: Framework is bundled with simple command-line interface specific to Swordfish
- Test early and often
  - CTP supports checking compliance level using mockups
  - Or, use an emulator as a test / development tool: Swordfish API Emulator enhanced to support CTP compliance
- Enhancements (some work in progress, some TBD):
  - SNIA authenticated self-run test result mechanism (e.g., certificate based authentication for CTP members for submitted test results)

```
(.venv) [root@e7f161f18cda swordfish-ctp-tests]# python ./run_snia_test.py -h
usage: run_snia_test.py [-h] [--user USER] [--password PASSWORD]
                       [--secure SECURE] [--authtype AUTHTYPE]
                       [--profiles PROFILES [PROFILES ...]]
                       [--profile_version PROFILE_VERSION]
                       host level

Python Script for the official Swordfish CTP Testing Suite.
  The hostname provided should be a full URI, as example `https://example.com:8000`.

  The hostname may also be provided as a mockup directory as formatted for the Redfish-Mockup-Server or Redfish-Protocol-Validator

  The following test levels are available:  serviceroottest, servicetest, officialtest

  After performing the run, your test directory will be output into your Swordfish-CTP-Tests folder as "test_dir_currentdate".

positional arguments:
  host                Full URL of System being tested (or directory of mockup)
  level              Level of testing

optional arguments:
  -h, --help          show this help message and exit
  --user USER, -u USER  Username for server
  --password PASSWORD, -p PASSWORD  Password of server
  --secure SECURE, -s SECURE  Ensures certificate checking on https servers
  --authtype AUTHTYPE  Specify that we are using redfish session or not
  --profiles PROFILES [PROFILES ...]  Specify profiles to test against service
  --profile_version PROFILE_VERSION  Default version of profiles to test against

(.venv) [root@e7f161f18cda swordfish-ctp-tests]#
```

# Test Results: Summary Results Available from Individual Test Runs

- Each run shows results of each test run
- Submit results when desired tests are passing
  - Redfish service-level tests required
  - Swordfish Discovery feature required
- From final / validated test results, these results will be transformed into results posted online at [snia.org/ctp](https://snia.org/ctp)
  - Results will be categorized as Base Redfish, and by Swordfish Feature – only “passed” features published



**Conformant**

### SNIA Swordfish(Tm) Conformance Test Program Results

**Start Time:** 2021-09-10 22:48:47  
**Duration:** 38.72 s  
**Summary:** Total: 5, Pass: 2, Fail: 3

Swordfish CTP Test	Status
Redfish Protocol Validator	Fail <a href="#">View</a>
Redfish URI Validator	Fail <a href="#">View</a>
SNIA Drives Capacity Test	Pass <a href="#">View</a>
SNIA Registries Test	Fail <a href="#">View</a>
SwordfishDiscovery	Pass <a href="#">View</a>

# Test Results: Published Results

- Final / validated test results will be posted online at [snia.org/swordfish-ctp](https://snia.org/swordfish-ctp)
  - Results will be categorized as Base Redfish, and by Swordfish Feature
  - Only “passed” features published

## Example Company "A"

### Official SNIA Swordfish™ CTP Test Results

CTP Test version: v1.2.2

Tested Software: Example Company "A" Storage Manager v1.2  
Swordfish version: v1.2.2



Conformant

Swordfish Conformant Tests
Redfish Protocol Tests
Swordfish Discovery
Swordfish Block Provisioning
Swordfish NVMe SSD Drive
Swordfish NVMe SSD Drive Advanced Features
Swordfish NVMe SSD Drive Ethernet Attach

Applicable Product Family: Example Company "A" NVMe SSD Ethernet-Attached Drives  
Products in Family: Product Name X01 NVMeGen3 Drive, NVMeGen4 Drive

[Company product family page.](#)

# Redfish Service Tests

/redfish/v1/ (response time: 0.003722) ServiceRoot				
/redfish/v1/ (response time: 0.003722)		Context: redfish/v1/\$metadata=#ServiceRoot.ServiceRoot File Origin: localFile:///.../metadata/ServiceRoot_v1.xml Resource Type: #ServiceRoot.v1_9_0.ServiceRoot		GET Success HTTP Code (200)
<a href="#">Show Results</a>  <a href="#">Show Payload</a>				pass: 8 passGet: 1 refine: 1 skipOptional: 25
Property Name	Value	Type	Exists	Result
@odata.context	redfish/v1/\$metadata=#ServiceRoot.ServiceRoot	odata	Exists	PASS
@odata.id	redfish/v1/	odata	Exists	PASS
@odata.type	#ServiceRoot.v1_9_0.ServiceRoot	odata	Exists	PASS
Storage	Link: /redfish/v1/Storage	link to: StorageCollection	Yes	PASS
AggregationService	-	link to: AggregationService	No	Optional
PowerEquipment	-	link to: PowerEquipment	No	Optional
Facilities	-	link to: FacilityCollection	No	Optional
Vendor	-	string	No	Optional
CertificateService	-	link to: CertificateService	No	Optional
ResourceBlocks	-	link to: ResourceBlockCollection	No	Optional
JobService	-	link to: JobService	No	Optional
TelemetryService	-	link to: TelemetryService	No	Optional
Product	-	string	No	Optional
ProtocolFeaturesSupported	-	ServiceRoot.v1_3_0.ProtocolFeaturesSupported	No	Optional
CompositionService	-	link to: CompositionService	No	Optional
StorageSystems	-	link to: StorageSystemCollection	No	Optional
StorageServices	-	link to: StorageServiceCollection	No	Optional
Fabrics	-	link to: FabricCollection	No	Optional
UpdateService	-	link to: UpdateService	No	Optional
RedfishVersion	1.12.0	string	Yes	PASS
UUID	92384634-2938-2342-8820-489239905423	GUID	Yes	PASS
Systems	-	link to: ComputerSystemCollection	No	Optional
Chassis	Link: /redfish/v1/Chassis	link to: ChassisCollection	Yes	PASS
Managers	-	link to: ManagerCollection	No	Optional
Tasks	-	link to: TaskService	No	Optional
SessionService	Link: /redfish/v1/SessionService	link to: SessionService	Yes	PASS
AccountService	-	link to: AccountService	No	Optional
EventService	-	link to: EventService	No	Optional
Registries	-	link to: MessageRegistryFileCollection	No	Optional
JsonSchemas	-	link to: JsonSchemaFileCollection	No	Optional
Links	[JSON Object]	ServiceRoot.v1_0_0.Links	Yes	complex
Links.Sessions	Link: /redfish/v1/SessionService/Sessions	link to: SessionCollection	Yes	PASS
Links.Oem	-	Resource.Oem	No	Optional
Id	RootService	string	Yes	PASS
Description	-	string	No	Optional
Name	Root Service	string	Yes	PASS
Oem	-	Resource.Oem	No	Optional
No errors				
No warns				

Service validator checks general conformance to schema

# Troubleshooting from Test Results

PhysicalPortAssignment	-	link to: NetworkPort	No	Optional
BootMode	Disabled	string (enum)	Yes	PASS
VirtualFunctionsEnabled	True	boolean	Yes	PASS
MaxVirtualFunctions	16	number	Yes	PASS
Links	[JSON Object]	NetworkDeviceFunction.v1_0_0.Links	Yes	complex
Links.EthernetInterfaces	Array (size: 1)	array of: EthernetInterface	Yes	...
Links.EthernetInterfaces[0]	Link: /redfish/v1/Chassis/EBOFEnclosure/NetworkAdapters/8fd725a1/NetworkDeviceFunctions/11100/EthernetInterfaces	EthernetInterface	Yes	FAIL
Links.OffloadSystem	-	link to: ComputerSystem	No	Optional
Links.OffloadProcessors	-	Processor	No	Optional
Links.PhysicalNetworkPortAssignment	-	link to: Port	No	Optional
Links.EthernetInterface	-	link to: EthernetInterface	No	Optional
Links.PhysicalPortAssignment	-	link to: NetworkPort	No	Optional
Links.Endpoints	-	Endpoint	No	Optional
Links.PCIeFunction	-	link to: PCIeFunction	No	Optional
Links.Oem	-	Resource.Oem	No	Optional
Id	11100	string	Yes	PASS
Description	-	string	No	Optional
Name	Network Device Function View	string	Yes	PASS
Oem	-	Resource.Oem	No	Optional

ERROR - Links.EthernetInterfaces[0]: Linked resource reports schema version (or namespace): EthernetInterface.EthernetInterface not found in typechain

WARNING - /redfish/v1/Chassis/EBOFEnclosure/NetworkAdapters/8fd725a1/NetworkDeviceFunctions/11101 @odata.id: Expected @odata.id to match URI link /redfish/v1/Chassis/EBOFEnclosure/NetworkAdapters/8fd725a1/NetworkDeviceFunctions/11100

- Descriptive messages show issues with any failures or warnings
- Additional log files available for more detailed reporting

# Individual Features Tests

Each test run has parameters, system info

Results show PASS/FAIL for each item

##### SNIA Swordfish (tm) Conformance Test Report #####



Tool Version: 2.0.0  
 Fri Sep 10 22:49:25 2021  
 (Run time: 0:00:00)

The Swordfish CTP Test Framework is provided and maintained by the SNIA. For feedback on the Swordfish CTP framework, go to:  
<https://www.snia.org/feedback>  
 This tool is provided and maintained by the DMTF. For feedback, please open issues in the tool's Github repository:  
<https://github.com/DMTF/Redfish-Service-Validator/issues>

Description: My Target System Root Service, version 1.12.0, 92384634-2938-2342-8820-489239905423  
 System: http://192.168.1.42:5000

Profile: ['./profiles/SwordfishDiscovery.json']  
 Schema: None

authtype: None, certificatebundle: None, certificatecheck: False, config: None  
 configuri: http://192.168.1.42:5000, debugging: False, forceauth: False, ip: http://192.168.1.42:5000  
 logdir: logdir, oemcheck: True, online\_profiles: True, payload: None  
 timeout: 10, token: None, username: , usessl: False  
 verbose: 0, warnrecommended: False, writecheck: False

/redfish/v1/ (response time: 0) ServiceRoot					
/redfish/v1/ (response time: 0) Show Results	Context: /redfish/v1 \$metadata=ServiceRoot.ServiceRoot File Origin: None Resource Type: #ServiceRoot.v1_9_0.ServiceRoot	GET Success	pass: 3 passGet: 1 totaltests: 3		
Property Name	Value	Expected	Actual	Result	
Storage.ReadRequirement	Mandatory	Must Exist	Exists	PASS	
Systems.ReadRequirement	Implemented	Any	DNE	PASS	
StorageSystems.ReadRequirement	Implemented	Any	DNE	PASS	
No errors					
No warns					
/redfish/v1/Storage (response time: 0) StorageCollection					
/redfish/v1/Storage (response time: 0) Show Results	Context: /redfish/v1 \$metadata=StorageCollection.StorageCollection File Origin: None Resource Type: #StorageCollection.StorageCollection	GET Success	pass: 2 passGet: 1 totaltests: 2		
Property Name	Value	Expected	Actual	Result	
Members.MinCount	1	<=	1	PASS	
Members#0.ReadRequirement	Mandatory	Must Exist	Exists	PASS	
No errors					
No warns					
/redfish/v1/Storage/IPAttachedDrive/Volumes (response time: 0) VolumeCollection					
/redfish/v1/Storage/IPAttachedDrive/Volumes (response time: 0) Show Results	Context: /redfish/v1 \$metadata=VolumeCollection.VolumeCollection File Origin: None Resource Type: #VolumeCollection.VolumeCollection	GET Success	pass: 2 passGet: 1 totaltests: 2		
Property Name	Value	Expected	Actual	Result	
Members.MinCount	0	<=	1	PASS	
Members#0.ReadRequirement	Mandatory	Must Exist	Exists	PASS	
No errors					
No warns					

# Where to Find More Info...

## SNIA Swordfish™

- **Swordfish Standards**
  - Schemas, Specs, Mockups, User and Practical Guide`s, ...  
<https://www.snia.org/swordfish>
- **Swordfish Specification Forum**
  - Ask and answer questions about Swordfish
  - <http://swordfishforum.com/>
- **Scalable Storage Management (SSM) TWG**
  - Technical Work Group that defines Swordfish
  - Influence the next generation of the Swordfish standard
  - Join SNIA & participate: [https://www.snia.org/member\\_com/join-SNIA](https://www.snia.org/member_com/join-SNIA)
- **Join the SNIA Storage Management Initiative**
  - Unifies the storage industry to develop and standardize interoperable storage management technologies
  - <https://www.snia.org/forums/smi/about/join>

## DMTF Redfish™

- **Redfish Standards**
  - Specifications, whitepapers, guides,...  
<https://www.dmtf.org/standards/redfish>



Redfish



## Open Fabric Management Framework

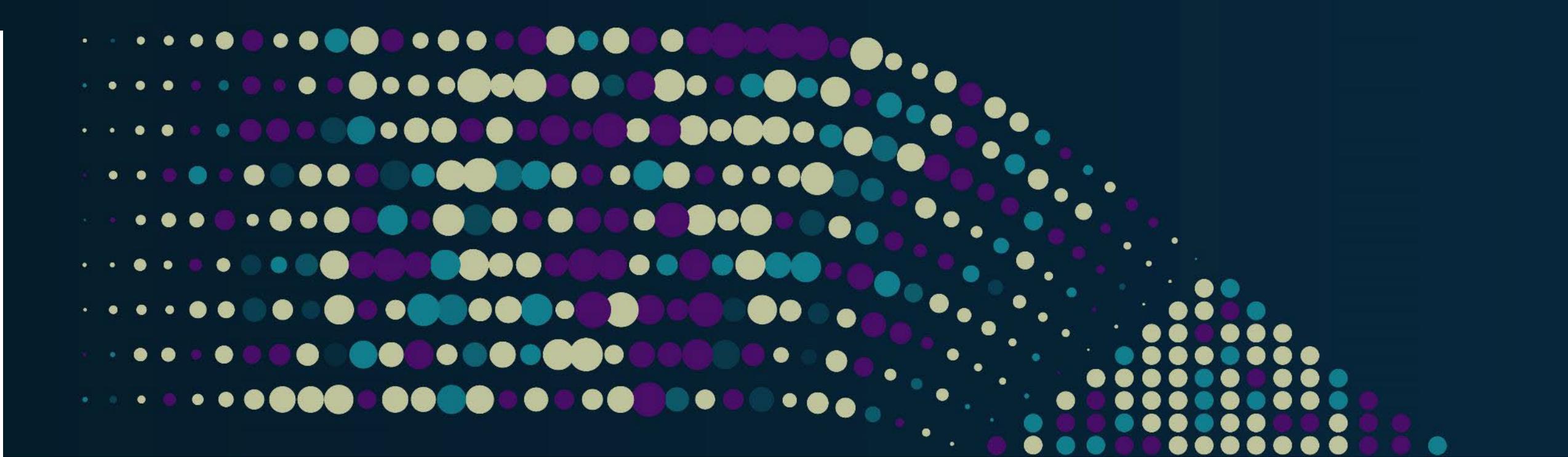
- **OFMF Working Group (OFMFWG)**
  - Description & Links <https://www.openfabrics.org/working-groups/>
- **OFMFWG mailing list subscription**
  - <https://lists.openfabrics.org/mailman/listinfo/ofmfwg>
- **Join the Open Fabrics Alliance**
  - <https://www.openfabrics.org/membership-how-to-join/>



## NVM Express

- **Specifications** <https://nvmexpress.org/developers/>
- **Join:** <https://nvmexpress.org/join-nvme/>





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