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**Abstract**

This document summarizes interfaces that are instrumental for the interaction with Clouds, Containers, and High Performance Computing (HPC) systems to manage virtual clusters to support the NIST Big Data Reference Architecture (NBDRA). The REpresentational State Transfer (REST) paradigm is used to define these interfaces, allowing easy integration and adoption by a wide variety of frameworks.

Big Data is a term used to describe extensive datasets, primarily in the characteristics of volume, variety, velocity, and/or variability. While opportunities exist with Big Data, the data characteristics can overwhelm traditional technical approaches, and the growth of data is outpacing scientific and technological advances in data analytics. To advance progress in Big Data, the NIST Big Data Public Working Group (NBD-PWG) is working to develop consensus on important fundamental concepts related to Big Data. The results are reported in the *NIST Big Data Interoperability Framework (NBDIF)* series of volumes. This volume, Volume 8, uses the work performed by the NBD-PWG to identify objects instrumental for the NIST Big Data Reference Architecture (NBDRA) which is introduced in the NBDIF: Volume 6, *Reference Architecture*.

**Keywords**

Adoption; barriers; implementation; interfaces; market maturity; organizational maturity; project maturity; system modernization.

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The following milestone releases exist:

* **Version 2.1**: A previous volume used just the definition of the schema based on examples it was easier to read but did only include the definition of the resources and not the interaction with the resources. This volume was in place till June 2018.
* **Version 2.2**: This version was significantly changed and uses now OpenAPI to specify the Interfaces between the various services and components. Editors of this volume are:
* **Version 3.1.1**: The version includes the significant improvements of the object specifications
* **Version 3.2.0**: All specifications have been updated to OpenAPI 3.0.2. Significant updates have been done to a number of specifications.

The editors for these documents are:

* Gregor von Laszewski (Indiana University)
* Wo Chang (NIST).

Laurie Aldape (Energetics Incorporated) Elizabeth Lennon (NIST) provided editorial assistance across all NBDIF volumes.

NIST SP 1500-9, Draft NIST Big Data Interoperability Framework: Volume 8, Reference Architecture Interfaces, Version 2 has been collaboratively authored by the NBD-PWG. As of the date of publication, there are over six hundred NBD-PWG participants from industry, academia, and government. Federal agency participants include the National Archives and Records Administration (NARA), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), and the U.S. Departments of Agriculture, Commerce, Defense, Energy, Census, Health and Human Services, Homeland Security, Transportation, Treasury, and Veterans Affairs.

NIST would like to acknowledge the specific contributions to this volume, during Version 1 and/or Version 2 activities. *Contributors* are members of the NIST Big Data Public Working Group who dedicated great effort to prepare and gave substantial time on a regular basis to research and development in support of this document. This includes the following NBD-PWG members:

* Gregor von Laszewski, Indiana University
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* Pratik Thakkar, Philips

**Executive Summary**

The *NIST Big Data Interoperability Framework (NBDIF): Volume 8, Reference Architecture Interfaces* document was prepared by the NIST Big Data Public Working Group (NBD-PWG) Reference Architecture Subgroup to identify interfaces in support of the NIST Big Data Reference Architecture (NBDRA) The interfaces contain two different aspects:

* The definition of resources that are part of the NBDRA. These resources are formulated in JavaScript Object Notation (JSON) format and can be easily integrated into a REpresentational State Transfer (REST) framework or an object-based framework.
* The definition of simple interface use cases that allow us to illustrate the usefulness of the resources defined.

The resources were categorized in groups that are identified by the NBDRA set forward in the *NBDIF: Volume 6, Reference Architecture* document. While the *NBDIF: Volume 3, Use Cases and General Requirements* document provides *application-*oriented high-level use cases, the use cases defined in this document are subsets of them and focus on *interface* use cases. The interface use cases are not meant to be complete examples, but showcase why the resource has been defined. Hence, the interfaces use cases are only representative, and do not encompass the entire spectrum of Big Data usage. All the interfaces were openly discussed in the working group (NIST, n.d.). Additions to the interfaces are welcome and the NBD-PWG is open to discuss any contributions.

The *NIST Big Data Interoperability Framework (NBDIF)* was released in three versions, which correspond to the three stages of the NBD-PWG work. Version 3 (current version) of the NBDIF volumes resulted from Stage 3 work with major emphasis on the validation of the NBDRA Interfaces and content enhancement. Stage 3 work built upon the foundation created during Stage 2 and Stage 1. The current effort documented in this volume reflects concepts developed within the rapidly evolving field of Big Data. The three stages (in reverse order) aim to achieve the following with respect to the NIST Big Data Reference Architecture (NBDRA).

Stage 3: Validate the NBDRA by building Big Data general applications through the general interfaces; Stage 2: Define general interfaces between the NBDRA components; and Stage 1: Identify the high-level Big Data reference architecture key components, which are technology-, infrastructure-, and vendor-agnostic.

The NBDIF consists of nine volumes, each of which addresses a specific key topic, resulting from the work of the NBD-PWG. The nine volumes are as follows:

* Volume 1, Definitions (W. L. Chang (Co-Chair), N. Grady (Subgroup Co-chair), and NIST Big Data Public Working Group 2019a)
* Volume 2, Taxonomies (W. L. Chang (Co-Chair), N. Grady (Subgroup Co-chair), and NIST Big Data Public Working Group 2019b)
* Volume 3, Use Cases and General Requirements (W. L. Chang (Co-Chair), G. Fox (Subgroup Co-chair), and NIST Big Data Public Working Group 2019)
* Volume 4, Security and Privacy (W. L. Chang (Co-Chair), A. Roy (Subgroup Co-chair), M. Underwood (Subgroup Co-chair), and NIST Big Data Public Working Group 2019)
* Volume 5, Architectures White Paper Survey (W. L. Chang (Co-Chair), S. Mishra (Editor), and NIST Big Data Public Working Group 2019)
* Volume 6, Reference Architecture (W. L. Chang (Co-Chair), D. Boyd (Subgroup Co-chair), O. Levin (Version 1 Subgroup Co-Chair), and NIST Big Data Public Working Group 2019)
* Volume 7, Standards Roadmap (W. L. Chang (Co-Chair), R. Reinsch (Subgroup Co-chair), D. Boyd (Version 1 Subgroup Co-chair), C. Buffington (Version 1 Subgroup Co-chair), and NIST Big Data Public Working Group 2019)
* Volume 8, Reference Architecture Interfaces (this volume) (W. L. Chang (Co-Chair), G. von Laszewski (Editor), and NIST Big Data Public Working Group 2019)
* Volume 9, Adoption and Modernization (W. L. Chang (Co-Chair), R. Reinsch (Subgroup Co-chair), C. Austin (Editor), and NIST Big Data Public Working Group 2019)

During Stage 1, Volumes 1 through 7 were conceptualized, organized and written. The finalized Version 1 documents can be downloaded from the V1.0 Final Version page of the NBD-PWG website (NIST 2015b).

During Stage 2, the NBD-PWG developed Version 2 of the NBDIF Version 1 volumes, with the exception of Volume 5, which contained the completed architecture survey work that was used to inform Stage 1 work of the NBD-PWG. The goals of Version 2 were to enhance the Version 1 content, define general interfaces between the NBDRA components by aggregating low-level interactions into high-level general interfaces, and demonstrate how the NBDRA can be used. As a result of the Stage 2 work, the need for NBDIF Volume 8 and NBDIF Volume 9 were identified and the two new volumes were created. Version 2 of the NBDIF volumes, resulting from Stage 2 work, can be downloaded from the V2.0Final Version page of the NBD-PWG website (NIST 2015a).

This document is the result of Stage 3 work of the NBD-PWG. Coordination of the group is conducted on the NBD-PWG web page (NIST, n.d.).

# Introduction

## Background

There is broad agreement among commercial, academic, and government leaders about the potential of Big Data to spark innovation, fuel commerce, and drive progress. Big Data is the common term used to describe the deluge of data in today’s networked, digitized, sensor-laden, and information-driven world. The availability of vast data resources carries the potential to answer questions previously out of reach, including the following:

* How can a potential pandemic reliably be detected early enough to intervene?
* Can new materials with advanced properties be predicted before these materials have ever been synthesized?
* How can the current advantage of the attacker over the defender in guarding against cybersecurity threats be reversed?

There is also broad agreement on the ability of Big Data to overwhelm traditional approaches. The growth rates for data volumes, speeds, and complexity are outpacing scientific and technological advances in data analytics, management, transport, and data user spheres.

Despite widespread agreement on the inherent opportunities and current limitations of Big Data, a lack of consensus on some important fundamental questions continues to confuse potential users and stymie progress. These questions include the following:

* How is Big Data defined?
* What attributes define Big Data solutions?
* What is new in Big Data?
* What is the difference between Big Data and *bigger data* that has been collected for years?
* How is Big Data different from traditional data environments and related applications?
* What are the essential characteristics of Big Data environments?
* How do these environments integrate with currently deployed architectures?
* What are the central scientific, technological, and standardization challenges that need to be addressed to accelerate the deployment of robust, secure Big Data solutions?

Within this context, on March 29, 2012, the White House announced the Big Data Research and Development Initiative (The White House Office of Science and Technology Policy, “Big Data is a Big Deal,” *OSTP Blog*, accessed February 21, 2014 (The White House Office of Science and Technology Policy 2014). The initiative’s goals include helping to accelerate the pace of discovery in science and engineering, strengthening national security, and transforming teaching and learning by improving analysts’ ability to extract knowledge and insights from large and complex collections of digital data.

Six federal departments and their agencies announced more than $200 million in commitments spread across more than 80 projects, which aim to significantly improve the tools and techniques needed to access, organize, and draw conclusions from huge volumes of digital data. The initiative also challenged industry, research universities, and nonprofits to join with the federal government to make the most of the opportunities created by Big Data.

Motivated by the White House initiative and public suggestions, the National Institute of Standards and Technology (NIST) accepted the challenge to stimulate collaboration among industry professionals to further the secure and effective adoption of Big Data. As a result of NIST’s Cloud and Big Data Forum held on January 15–17, 2013, there was strong encouragement for NIST to create a public working group for the development of a Big Data Standards Roadmap. Forum participants noted that this roadmap should define and prioritize Big Data requirements, including interoperability, portability, reusability, extensibility, data usage, analytics, and technology infrastructure. In doing so, the roadmap would accelerate the adoption of the most secure and effective Big Data techniques and technology.

On June 19, 2013, the NIST Big Data Public Working Group (NBD-PWG) was launched with extensive participation by industry, academia, and government from across the nation. The scope of the NBD-PWG involves forming a community of interests from all sectors—including industry, academia, and government—with the goal of developing consensus on definitions, taxonomies, secure reference architectures, security and privacy, and, from these, a standards roadmap. Such a consensus would create a vendor-neutral, technology- and infrastructure-independent framework that would enable Big Data stakeholders to identify and use the best analytics tools for their processing and visualization requirements on the most suitable computing platform and cluster, while also allowing added value from Big Data service providers.

The *NIST Big Data Interoperability Framework (NBDIF)* was released in three versions, which correspond to the three stages of the NBD-PWG work. Version 3 (current version) of the NBDIF volumes resulted from Stage 3 work with major emphasis on the validation of the NBDRA Interfaces and content enhancement. Stage 3 work built upon the foundation created during Stage 2 and Stage 1. The current effort documented in this volume reflects concepts developed within the rapidly evolving field of Big Data. The three stages (in reverse order) aim to achieve the following with respect to the NIST Big Data Reference Architecture (NBDRA).

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## Scope and Objectives of the Reference Architectures Subgroup

Reference architectures provide “an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions” (Department of Defense 2010). Reference architectures generally serve as a foundation for solution architectures and may also be used for comparison and alignment of instantiations of architectures and solutions.

The goal of the NBD-PWG Reference Architecture Subgroup is to develop an open reference architecture for Big Data that achieves the following objectives:

* Provides a common language for the various stakeholders;
* Encourages adherence to common standards, specifications, and patterns;
* Provides consistent methods for implementation of technology to solve similar problem sets;
* Illustrates and improves understanding of the various Big Data components, processes, and systems, in the context of a vendor- and technology-agnostic Big Data conceptual model;
* Provides a technical reference for U.S. government departments, agencies, and other consumers to understand, discuss, categorize, and compare Big Data solutions; and
* Facilitates analysis of candidate standards for interoperability, portability, reusability, and extendibility.

The NBDRA is a high-level conceptual model crafted to serve as a tool to facilitate open discussion of the requirements, design structures, and operations inherent in Big Data. The NBDRA is intended to facilitate the understanding of the operational intricacies in Big Data. It does not represent the system architecture of a specific Big Data system, but rather is a tool for describing, discussing, and developing system-specific architectures using a common framework of reference. The model is not tied to any specific vendor products, services, or reference implementation, nor does it define prescriptive solutions that inhibit innovation.

The NBDRA does not address the following:

* Detailed specifications for any organization’s operational systems;
* Detailed specifications of information exchanges or services; and
* Recommendations or standards for integration of infrastructure products.

The goals of the Subgroup were realized throughout the three planned phases of the NBD-PWG work, as outlined in sec. 1.3.

## Report Production

The *NBDIF: Volume 8,* *References Architecture Interfaces* is one of nine volumes, whose overall aims are to define and prioritize Big Data requirements, including interoperability, portability, reusability, extensibility, data usage, analytic techniques, and technology infrastructure to support secure and effective adoption of Big Data. The overall goals of this volume are to define and specify interfaces to implement the Big Data Reference Architecture. This volume arose from discussions during the weekly NBD-PWG conference calls. Topics included in this volume began to take form in Phase 2 of the NBD-PWG work. During the discussions, the NBD-PWG identified the need to specify a variety of interfaces.

Phase 3 work, which built upon the groundwork developed during Phase 2, included an early specification based on resource object specifications that provided a simplified version of an API interface design.

## Report Structure

To enable interoperability between the NBDRA components, a list of well-defined NBDRA interfaces is needed. These interfaces are documented in this volume. To introduce them, the NBDRA structure will be followed, focusing on interfaces that allow bootstrapping of the NBDRA. The document begins with a summary of requirements that will be integrated into our specifications. Subsequently, each section will introduce a number of objects that build the core of the interface addressing a specific aspect of the NBDRA. A selected number of *interface use cases* will be showcased to outline how the specific interface can be used in a reference implementation of the NBDRA. Validation of this approach can be achieved while applying it to the application use cases that have been gathered in the *NBDIF: Volume 3, Use Cases and Requirements* document. These application use cases have considerably contributed towards the design of the NBDRA. Hence the expectation is that: (1) the interfaces can be used to help implement a Big Data architecture for a specific use case; and (2) the proper implementation. This approach can facilitate subsequent analysis and comparison of the use cases.

The organization of this document roughly corresponds to the process used by the NBD-PWG to develop the interfaces. Following the introductory material presented in sec. 1, the remainder of this document is organized as follows:

* sec. 2 presents the interface requirements;
* sec. 3 presents the specification paradigm that is used;
* sec. 4 presents several objects grouped by functional use while providing a summary table of selected proposed objects in sec. 4.1.

While each NBDIF volume was created with a specific focus within Big Data, all volumes are interconnected. During creation, the volumes gave and/or received input from other volumes. Broad topics (e.g., definition, architecture) may be discussed in several volumes with the discussion circumscribed by the volume’s particular focus. Arrows shown in fig. 1 indicate the main flow of input/output. Volumes 2, 3, and 5 (blue circles) are essentially standalone documents that provide output to other volumes (e.g., to Volume 6). These volumes contain the initial situational awareness research. Volumes 4, 7, 8, and 9 (green circles) primarily received input from other volumes during the creation of the particular volume. Volumes 1 and 6 (red circles) were developed using the initial situational awareness research and continued to be modified based on work in other volumes. These volumes also provided input to the green circle volumes.



Figure 1: Figure 1: NBDIF Documents Navigation Diagram Provides Content Flow Between Volumes

# NBDRA Interface Requirements

The development of a Big Data reference architecture requires a thorough understanding of current techniques, issues, and concerns. To this end, the NBD-PWG collected use cases to gain an understanding of current applications of Big Data, conducted a survey of reference architectures to understand commonalities within Big Data architectures in use, developed a taxonomy to understand and organize the information collected, and reviewed existing technologies and trends relevant to Big Data. The results of these NBD-PWG activities were used in the development of the NBDRA (fig. 2) and the interfaces presented herein. Detailed descriptions of these activities can be found in the other volumes of the *NBDIF*.



Figure 2: Figure 2: NIST Big Data Reference Architecture (NBDRA)

This vendor-neutral, technology- and infrastructure-agnostic conceptual model, the NBDRA, is shown in fig. 2 and represents a Big Data system composed of five logical functional components connected by interoperability interfaces (i.e., services). Two fabrics envelop the components, representing the interwoven nature of management and security and privacy with all five of the components. These two fabrics provide services and functionality to the five main roles in the areas specific to Big Data and are crucial to any Big Data solution. Note: None of the terminology or diagrams in these documents is intended to be normative or to imply any business or deployment model. The terms *provider* and *consumer* as used are descriptive of general roles and are meant to be informative in nature.

The NBDRA is organized around five major roles and multiple sub-roles aligned along two axes representing the two Big Data value chains: the Information Value (horizontal axis) and the Information Technology (IT; vertical axis). Along the Information Value axis, the value is created by data collection, integration, analysis, and applying the results following the value chain. Along the IT axis, the value is created by providing networking, infrastructure, platforms, application tools, and other IT services for hosting of and operating the Big Data in support of required data applications. At the intersection of both axes is the Big Data Application Provider role, indicating that data analytics and its implementation provide the value to Big Data stakeholders in both value chains. The term *provider* as part of the Big Data Application Provider and Big Data Framework Provider is there to indicate that those roles provide or implement specific activities and functions within the system. It does not designate a service model or business entity.

The DATA arrows in fig. 2 show the flow of data between the system’s main roles. Data flows between the roles either physically (i.e., by value) or by providing its location and the means to access it (i.e., by reference). The SW arrows show transfer of software tools for processing of Big Data *in situ*. The Service Use arrows represent software programmable interfaces. While the main focus of the NBDRA is to represent the run-time environment, all three types of communications or transactions can happen in the configuration phase as well. Manual agreements (e.g., service-level agreements) and human interactions that may exist throughout the system are not shown in the NBDRA.

Detailed information on the NBDRA conceptual model is presented in the *NBDIF: Volume 6, Reference Architecture* document.

Prior to outlining the specific interfaces, general requirements are introduced and the interfaces are defined.

## High-Level Requirements of the Interface Approach

This section focuses on the high-level requirements of the interface approach that are needed to implement the reference architecture depicted in fig. 2.

### Technology- and Vendor-Agnostic

Due to the many different tools, services, and infrastructures available in the general area of Big Data, an interface ought to be as vendor-independent as possible, while, at the same time, be able to leverage best practices. Hence, a methodology is needed that allows extension of interfaces to adapt and leverage existing approaches, but also allows the interfaces to provide merit in easy specifications that assist the formulation and definition of the NBDRA.

### Support of Plug-In Compute Infrastructure

As Big Data is not just about hosting data, but about analyzing data, the interfaces provided herein must encapsulate a rich infrastructure environment that is used by data scientists. This includes the ability to integrate (or plug-in) various compute resources and services to provide the necessary compute power to analyze the data. These resources and services include the following:

* Access to hierarchy of compute resources from the laptop/desktop, servers, data clusters, and clouds;
* The ability to integrate special-purpose hardware such as graphics processing units (GPUs) and field-programmable gate arrays (FPGAs) that are used in accelerated analysis of data; and
* The integration of services including microservices that allow the analysis of the data by delegating them to hosted or dynamically deployed services on the infrastructure of choice.

### Orchestration of Infrastructure and Services

From review of the use case collection, presented in the *NBDIF: Volume 3, Use Cases and General Requirements* document (W. L. Chang (Co-Chair), G. Fox (Subgroup Co-chair), and NIST Big Data Public Working Group 2019), the need arose to address the mechanism of preparing suitable infrastructures for various use cases. As not every infrastructure is suited for every use case, a custom infrastructure may be needed. As such, this document is not attempting to deliver a single deployed NBDRA, but allow the setup of an infrastructure that satisfies the particular use case. To achieve this task, it is necessary to provision software stacks and services while orchestrating their deployment and leveraging infrastructures. It is not the focus of this document to replace existing orchestration software and services, but provide an interface to them to leverage them as part of defining and creating the infrastructure. Various orchestration frameworks and services could therefore be leveraged, even as part of the same framework, and work in orchestrated fashion to achieve the goal of preparing an infrastructure suitable for one or more applications.

### Orchestration of Big Data Applications and Experiments

The creation of the infrastructure suitable for Big Data applications provides the basic computing environment. However, Big Data applications may require the creation of sophisticated applications as part of interactive experiments to analyze and probe the data. For this purpose, the applications must be able to orchestrate and interact with experiments conducted on the data while assuring reproducibility and correctness of the data. For this purpose, a *System Orchestrator* (either the data scientists or a service acting on behalf of the data scientist) is used as the command center to interact on behalf of the Big Data Application Provider to orchestrate dataflow from Data Provider, carry out the Big Data application life cycle with the help of the Big Data Framework Provider, and enable the Data Consumer to consume Big Data processing results. An interface is needed to describe these interactions and to allow leveraging of experiment management frameworks in scripted fashion. A customization of parameters is needed on several levels. On the highest level, application-motivated parameters are needed to drive the orchestration of the experiment. On lower levels, these high-level parameters may drive and create service-level agreements, augmented specifications, and parameters that could even lead to the orchestration of infrastructure and services to satisfy experiment needs.

### Reusability

The interfaces provided must encourage reusability of the infrastructure, services, and experiments described by them. This includes (1) reusability of available analytics packages and services for adoption; (2) deployment of customizable analytics tools and services; and (3) operational adjustments that allow the services and infrastructure to be adapted while at the same time allowing for reproducible experiment execution.

### Execution Workloads

One of the important aspects of distributed Big Data services can be that the data served is simply too big to be moved to a different location. Instead, an interface could allow the description and packaging of analytics algorithms, and potentially also tools, as a payload to a data service. This can be best achieved, not by sending the detailed execution, but by sending an interface description that describes how such an algorithm or tool can be created on the server and be executed under security considerations (integrated with authentication and authorization in mind).

### Security and Privacy Fabric Requirements

Although the focus of this document is not security and privacy, which are documented in the *NBDIF: Volume 4, Security and Privacy* (W. L. Chang (Co-Chair), A. Roy (Subgroup Co-chair), M. Underwood (Subgroup Co-chair), and NIST Big Data Public Working Group 2019), the interfaces defined herein must be capable of integration into a secure reference architecture that supports secure execution, secure data transfer, and privacy. Consequently, the interfaces defined herein can be augmented with frameworks and solutions that provide such mechanisms. Thus, diverse requirement needs stemming from different use cases addressing security need to be distinguished. To contrast that the security requirements between applications can vary drastically, the following example is provided. Although many of the interfaces and their objects to support Big Data applications in physics are similar to those in healthcare, they differ in the integration of security interfaces and policies. While in physics the protection of data is less of an issue, it is a stringent requirement in healthcare. Thus, deriving architectural frameworks for both may use largely similar components, but addressing security issues will be very different. The security of interfaces may be addressed in other documents. In this document, they are considered an advanced use case showcasing that the validity of the specifications introduced here is preserved, even if security and privacy requirements differ vastly among application use cases.

## Component-Specific Interface Requirements

This section summarizes the requirements for the interfaces of the NBDRA components. The five components are listed in fig. 2 and addressed in sec. 2.2.1 (System Orchestrator Interface Requirements) and sec. 2.2.4 (Big Data Application Provider to Big Data Framework Provider Interface) of this document. The five main functional components of the NBDRA represent the different technical roles within a Big Data system and are the following:

* System Orchestrator: Defines and integrates the required data application activities into an operational vertical system (see sec. 2.2.1);
* Data Provider: Introduces new data or information feeds into the Big Data system (see sec. 2.2.2);
* Data Consumer: Includes end users or other systems that use the results of the Big Data Application Provider (see sec. 2.2.3);
* Big Data Application Provider: Executes a data life cycle to meet security and privacy requirements as well as System Orchestrator-defined requirements (see sec. 2.2.4);
* Big Data Framework Provider: Establishes a computing framework in which to execute certain transformation applications while protecting the privacy and integrity of data (see sec. 2.2.5); and
* Big Data Application Provider to Framework Provider Interface: Defines an interface between the application specification and the provider (see sec. 2.2.6).

### System Orchestrator Interface Requirements

The System Orchestrator role includes defining and integrating the required data application activities into an operational vertical system. Typically, the System Orchestrator involves a collection of more specific roles, performed by one or more actors, which manage and orchestrate the operation of the Big Data system. These actors may be human components, software components, or some combination of the two. The function of the System Orchestrator is to configure and manage the other components of the Big Data architecture to implement one or more workloads that the architecture is designed to execute. The workloads managed by the System Orchestrator may be assigning/provisioning framework components to individual physical or virtual nodes at the lower level, or providing a graphical user interface that supports the specification of workflows linking together multiple applications and components at the higher level. The System Orchestrator may also, through the Management Fabric, monitor the workloads and system to confirm that specific quality of service requirements is met for each workload, and may elastically assign and provision additional physical or virtual resources to meet workload requirements resulting from changes/surges in the data or number of users/transactions. The interface to the System Orchestrator must be capable of specifying the task of orchestration the deployment, configuration, and the execution of applications within the NBDRA. A simple vendor-neutral specification to coordinate the various parts either as simple parallel language tasks or as a workflow specification is needed to facilitate the overall coordination. Integration of existing tools and services into the System Orchestrator as extensible interfaces is desirable.

### Data Provider Interface Requirements

The Data Provider role introduces new data or information feeds into the Big Data system for discovery, access, and transformation by the Big Data system. New data feeds are distinct from the data already in use by the system and residing in the various system repositories. Similar technologies can be used to access both new data feeds and existing data. The Data Provider actors can be anything from a sensor, to a human inputting data manually, to another Big Data system. Interfaces for data providers must be able to specify a data provider so it can be located by a data consumer. It also must include enough details to identify the services offered so they can be pragmatically reused by consumers. Interfaces to describe pipes and filters must be addressed.

### Data Consumer Interface Requirements

Like the Data Provider, the role of Data Consumer within the NBDRA can be an actual end user or another system. In many ways, this role is the mirror image of the Data Provider, with the entire Big Data framework appearing like a Data Provider to the Data Consumer. The activities associated with the Data Consumer role include the following:

* Search and Retrieve,
* Download,
* Analyze Locally,
* Reporting,
* Visualization, and
* Data to Use for Their Own Processes.

The interface for the data consumer must be able to describe the consuming services and how they retrieve information or leverage data consumers.

### Big Data Application Interface Provider Requirements

The Big Data Application Provider role executes a specific set of operations along the data life cycle to meet the requirements established by the System Orchestrator, as well as meeting security and privacy requirements. The Big Data Application Provider is the architecture component that encapsulates the business logic and functionality to be executed by the architecture. The interfaces to describe Big Data applications include interfaces for the various subcomponents including collections, preparation/curation, analytics, visualization, and access. Some of the interfaces used in these subcomponents can be reused from other interfaces, which are introduced in other sections of this document. Where appropriate, application-specific interfaces will be identified and examples provided with a focus on use cases as identified in the *NBDIF: Volume 3, Use Cases and General Requirements*.

#### Collection

In general, the collection activity of the Big Data Application Provider handles the interface with the Data Provider. This may be a general service, such as a file server or web server configured by the System Orchestrator to accept or perform specific collections of data, or it may be an application-specific service designed to pull data or receive pushes of data from the Data Provider. Since this activity is receiving data at a minimum, it must store/buffer the received data until it is persisted through the Big Data Framework Provider. This persistence need not be to physical media but may simply be to an in-memory queue or other service provided by the processing frameworks of the Big Data Framework Provider. The collection activity is likely where the extraction portion of the Extract, Transform, Load (ETL)/Extract, Load, Transform (ELT) cycle is performed. At the initial collection stage, sets of data (e.g., data records) of similar structure are collected (and combined), resulting in uniform security, policy, and other considerations. Initial metadata is created (e.g., subjects with keys are identified) to facilitate subsequent aggregation or look-up methods.

#### Preparation

The preparation activity is where the transformation portion of the ETL/ELT cycle is likely performed, although analytics activity will also likely perform advanced parts of the transformation. Tasks performed by this activity could include data validation (e.g., checksums/hashes, format checks), cleansing (e.g., eliminating bad records/fields), outlier removal, standardization, reformatting, or encapsulating. This activity is also where source data will frequently be persisted to archive storage in the Big Data Framework Provider and provenance data will be verified or attached/associated. Verification or attachment may include optimization of data through manipulations (e.g., deduplication) and indexing to optimize the analytics process. This activity may also aggregate data from different Data Providers, leveraging metadata keys to create an expanded and enhanced data set.

#### Analytics

The analytics activity of the Big Data Application Provider includes the encoding of the low-level business logic of the Big Data system (with higher-level business process logic being encoded by the System Orchestrator). The activity implements the techniques to extract knowledge from the data based on the requirements of the vertical application. The requirements specify the data processing algorithms to produce new insights that will address the technical goal. The analytics activity will leverage the processing frameworks to implement the associated logic. This typically involves the activity providing software that implements the analytic logic to the batch and/or streaming elements of the processing framework for execution. The messaging/communication framework of the Big Data Framework Provider may be used to pass data or control functions to the application logic running in the processing frameworks. The analytic logic may be broken up into multiple modules to be executed by the processing frameworks which communicate, through the messaging/communication framework, with each other and other functions instantiated by the Big Data Application Provider.

#### Visualization

The visualization activity of the Big Data Application Provider prepares elements of the processed data and the output of the analytic activity for presentation to the Data Consumer. The objective of this activity is to format and present data in such a way as to optimally communicate meaning and knowledge. The visualization preparation may involve producing a text-based report or rendering the analytic results as some form of graphic. The resulting output may be a static visualization and may simply be stored through the Big Data Framework Provider for later access. However, the visualization activity frequently interacts with the access activity, the analytics activity, and the Big Data Framework Provider (processing and platform) to provide interactive visualization of the data to the Data Consumer based on parameters provided to the access activity by the Data Consumer. The visualization activity may be completely application-implemented, leverage one or more application libraries, or may use specialized visualization processing frameworks within the Big Data Framework Provider.

#### Access

The access activity within the Big Data Application Provider is focused on the communication/interaction with the Data Consumer. Like the collection activity, the access activity may be a generic service such as a web server or application server that is configured by the System Orchestrator to handle specific requests from the Data Consumer. This activity would interface with the visualization and analytic activities to respond to requests from the Data Consumer (who may be a person) and uses the processing and platform frameworks to retrieve data to respond to Data Consumer requests. In addition, the access activity confirms that descriptive and administrative metadata and metadata schemes are captured and maintained for access by the Data Consumer and as data is transferred to the Data Consumer. The interface with the Data Consumer may be synchronous or asynchronous in nature and may use a pull or push paradigm for data transfer.

### Big Data Provider Framework Interface Requirements

Data for Big Data applications are delivered through data providers. They can be either local providers, data contributed by a user, or distributed data providers, data on the Internet. This interface must be able to provide the following functionality:

* Interfaces to files,
* Interfaces to virtual data directories,
* Interfaces to data streams, and
* Interfaces to data filters.

#### Infrastructures Interface Requirements

This Big Data Framework Provider element provides all the resources necessary to host/run the activities of the other components of the Big Data system. Typically, these resources consist of some combination of physical resources, which may host/support similar virtual resources. The NBDRA needs interfaces that can be used to deal with the underlying infrastructure to address networking, computing, and storage.

#### Platforms Interface Requirements

As part of the NBDRA platforms, interfaces are needed that can address platform needs and services for data organization, data distribution, indexed storage, and file systems.

#### Processing Interface Requirements

The processing frameworks for Big Data provide the necessary infrastructure software to support implementation of applications that can deal with the volume, velocity, variety, and variability of data. Processing frameworks define how the computation and processing of the data is organized. Big Data applications rely on various platforms and technologies to meet the challenges of scalable data analytics and operation. A requirement is the ability to interface easily with computing services that offer specific analytics services, batch processing capabilities, interactive analysis, and data streaming.

#### Crosscutting Interface Requirements

Several crosscutting interface requirements within the Big Data Framework Provider include messaging, communication, and resource management. Often these services may be hidden from explicit interface use as they are part of larger systems that expose higher-level functionality through their interfaces. However, such interfaces may also be exposed on a lower level in case finer-grained control is needed. The need for such crosscutting interface requirements will be extracted from the *NBDIF: Volume 3, Use Cases and General Requirements* document.

#### Messaging/Communications Frameworks

Messaging and communications frameworks have their roots in the High Performance Computing environments long popular in the scientific and research communities. Messaging/Communications Frameworks were developed to provide application programming interfaces (APIs) for the reliable queuing, transmission, and receipt of data.

#### Resource Management Framework

As Big Data systems have evolved and become more complex, and as businesses work to leverage limited computation and storage resources to address a broader range of applications and business challenges, the requirement to effectively manage those resources has grown significantly. While tools for resource management and *elastic computing* have expanded and matured in response to the needs of cloud providers and virtualization technologies, Big Data introduces unique requirements for these tools. However, Big Data frameworks tend to fall more into a distributed computing paradigm, which presents additional challenges.

### Big Data Application Provider to Big Data Framework Provider Interface

The Big Data Framework Provider typically consists of one or more hierarchically organized instances of the components in the NBDRA IT value chain (fig. 2). There is no requirement that all instances at a given level in the hierarchy be of the same technology. In fact, most Big Data implementations are hybrids that combine multiple technology approaches to provide flexibility or meet the complete range of requirements, which are driven from the Big Data Application Provider.

# Specification Paradigm

This section summarizes the elementary services that are important to the NBDRA.

## Hybrid and Multiple Frameworks

To avoid vendor lock-in, Big Data systems must be able to deal with hybrid and multiple frameworks. This is not only true for Clouds, containers, DevOps, but also for components of the NBDRA.

## Design by Resource-Oriented Architecture

A resource-oriented architecture represents a software architecture and programming paradigm for designing and developing software in the form of resources. It is often associated with *REpresentational State Transfer (REST)* interfaces. The resources are software components which can be reused in concrete reference implementations. The service specification is conducted with OpenAPI, allowing use to provide it in a very general form that is independent of the framework or computer language in which the services can be specified. Note that OpenAPI defines services in REST The previous version only specified the resource objects.

## Design by Example

To accelerate discussion among the NBD-PWG members, contributors to this document are encouraged to also provide the NBD-PWG with examples that can be included in an appendix.

## Version Management

During the design phase and development period of each version of this document, enhancements are managed through GitHub and community contributions are managed via GitHub issues. This allows preservation of the history of this document. When a new version is ready, the version will be tagged in GitHub. Older versions will, through this process, also be available as historical documents. Discussions about objects in written form are communicated as GitHub issues (Laszewski 2019b).

Previos documents that lead up to this document are (Laszewski et al. 2015)(Laszewski et al. 2017).

## Interface Compliancy

Due to the easy extensibility of the objects in this document and their implicit interfaces, it is important to introduce a terminology that allows the definition of interface compliancy. We define three levels of interface compliance as follows:

* **Full Compliance:** These are reference implementations that provide full compliance to the objects defined in this document. A version number will be added to assure that the snapshot in time of the objects is associated with the version. This reference implementation will implement all objects.
* **Partial Compliance:** These are reference implementations that provide partial compliance to the objects defined in this document. A version number will be added to assure that the snapshot in time of the objects is associated with the version. This reference implementation will implement a partial list of the objects. A document will be generated during the reference implementation that lists all objects defined, but also lists the objects that are not defined by the reference architecture. The document will outline which objects and interfaces have been implemented.
* **Full and Extended Compliance:** These are interfaces that in addition to the full compliance also introduce additional interfaces and extend them. A document will be generated during the reference implementation that lists the differences to the document defined here.

The documents generated during the reference implementation can then be forwarded to the Reference Architecture Subgroup for further discussion and for possible future modifications based on additional practical user feedback.

# Specification

The specifications to this document are provided through an automated document creation process so that the actual OpenAPI specifications are the source for the document. Thus we will have all OpenAPI specifications located in the following directory in GitHub (Laszewski 2019c).

Limitations of the current implementation are as follows. It is a demonstration that showcases the generation of a fully functioning REST service based on the specifications provided in this document. However, it is expected that scalability, distribution of services, and other advanced options need to be addressed based on application requirements.

## List of specifications

The following table lists the current set of resource objects that are defined in this draft. Additional objects are also available in Github (Laszewski 2019c).

tbl. 1 shows the list of currently included specification in this version of the document.

Table 1: Table 1: Specifications

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Service | Version | Date | Reference | Section |  |
| Alias | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/alias.yaml) | sec. 4.3.2 |  |
| Database | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/database.yaml) | sec. 4.4.3 |  |
| Default | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/default.yaml) | sec. 4.3.4 |  |
| File | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/filestore.yaml) | sec. 4.4.1 |  |
| Flavor | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/flavor.yaml) | sec. 4.6.2 |  |
| Image | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/image.yaml) | sec. 4.6.1 |  |
| Nic | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/nic.yaml) | sec. 4.6.5 |  |
| Organization | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/organization.yaml) | sec. 4.2.2 |  |
| Public Key Store | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/publickeystore.yaml) | sec. 4.2.4 |  |
| Replica | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/replica.yaml) | sec. 4.4.2 |  |
| Reservation | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/reservation.yaml) | sec. 4.9.1 |  |
| Scheduler | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/scheduler.yaml) | sec. 4.5.2 |  |
| Secgroup | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/secgroup.yaml) | sec. 4.6.4 |  |
| Timestamp | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/timestamp.yaml) | sec. 4.3.1 |  |
| User | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/user.yaml) | sec. 4.2.3 |  |
| Variables | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/variables.yaml) | sec. 4.3.3 |  |
| Virtual Cluster | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/virtualcluster.yaml) | sec. 4.5.1 |  |
| Virtual Directory | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/virtualdirectory.yaml) | sec. 4.4.4 |  |
| Virtual Machine | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/vm.yaml) | sec. 4.6.3 |  |
| Containers | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/containers.yaml) | sec. 4.7.1 |  |
| Deployment | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/deployment.yaml) | sec. 4.11.1 |  |
| Filter | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/filter.yaml) | sec. 4.10.2 |  |
| Microservice | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/microservice.yaml) | sec. 4.8.1 |  |
| Stream | 3.2.0 | 008-06-2019 | [☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/stream.yaml) | sec. 4.10.1 |  |

fig. 3 shows the provider view of the specification resources.



Figure 3: Figure 3: Provider view

fig. 4 shows the resources view of the specification resources.



Figure 4: Figure 4: Resource view

## Identity

As part of services an identity often needs to be specified. In addition, such persons ( Internet2 Middleware Architecture Committee for Education 2016) are often part of groups and have roles within these groups. Thus, four important terms related to the identity are distinguished as follows:

* User: The information identifying the profile of a person
* Group: A group that a person may belong to that is important to define access to services
* Role: A role given to a person as part of the group that can refine access rights.
* Organization: The information representing an Organization that manages a Big Data Service

### Authentication

At this time, mechanisms are not yet included to manage authentication to external services such as clouds that can stage virtual machines. However, the group has shown multiple solutions to this in cloudmesh.

* Local configuration file: A configuration file is managed locally to allow access to the clouds. It is the designer’s responsibility not to expose such credentials.
* Session based authentication: No passwords are stored in the configuration file and access is granted on a per session basis where the password needs to be entered.
* Service based authentication: The authentication is delegated to an external process. One example here is Auth.
* The service that acts in behalf of the user needs to have access to the appropriate cloud provider credentials

An example for a configuration file is provided at (Laszewski 2019a).

### Organization

An important concept in many services is the management of a group of users in an organization. Within an organization we distinguish different Groups of users and within a Group we can have different roles users can fulfill. Such groups and rols can be used to specify access rights to services.

#### Schema Organization

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/organization.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | Name of the organization |
| users | array[User] | list of users |

#### Schema Group

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/group.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | The name of the group |
| description | string | The description of the group |
| users | array[string] | The user names that are member of the group |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /organization | Returns a list of organizations |
| put | /organization | Uploads an organization to the list of organizations |
| get | /organization/{name} | Returns the named organization |
| delete | /organization/{name} | Deletes the named organization |
| get | /organization/{name}/user | Returns all users of the organization |
| get | /organization/{name}/user/{username} | Returns the specific user of that organization |
| put | /organization/{name}/user/{username} | Updates or adds a user in the organization |
| delete | /organization/{name}/user/{username} | Delete an user in the organization |
| get | /organization/{name}/group/ | Returns all group names |
| get | /organization/{name}/group/{groupname} | Returns the specific group of that organization |
| put | /organization/{name}/group/{groupname} | Updates or adds a group in the organization |
| delete | /organization/{name}/group/{groupname} | Delete a group in the organization |
| put | /organization/{name}/group/{groupname}/{username} | Updates or adds a username to the group |

##### /organization

###### GET /organization

Returns a list of all organizations

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of organizations |  |
| 400 | No Organizations found. |  |

###### PUT /organization

Uploads an organization to the list of organizations

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Organization updated. |  |
| 400 | Error updateing Organization. |  |

##### /organization/{name}

###### GET /organization/{name}

Returns an organization by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No organization found. |  |
| 404 | The named organization could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the organization | True |  |

###### DELETE /organization/{name}

Deletes an organization by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Organization found. |  |
| 404 | The named organization could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the organization | True |  |

##### /organization/{name}/user

###### GET /organization/{name}/user

Returns all users of the organization

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | organization info |  |

##### /organization/{name}/user/{username}

###### GET /organization/{name}/user/{username}

Returns the specific user of that organization

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | organization info |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the organization | True |  |
| username | path | The username | True |  |

###### PUT /organization/{name}/user/{username}

Updates or adds a user in the organization

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | User added sucessfully |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the organization | True |  |

###### DELETE /organization/{name}/user/{username}

Delete an user in the organization

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the organization | True |  |
| username | path | The username | True |  |

##### /organization/{name}/group/

###### GET /organization/{name}/group/

Returns all group names

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No group found. |  |
| 404 | The named group could not be found. |  |

##### /organization/{name}/group/{groupname}

###### GET /organization/{name}/group/{groupname}

Returns the specific group of that organization

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | organization info |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the organization | True |  |
| groupname | path | The groupname | True |  |

###### PUT /organization/{name}/group/{groupname}

Updates or adds a group in the organization

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Group added sucessfully |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the group | True |  |
| groupname | path | The groupname | True |  |

###### DELETE /organization/{name}/group/{groupname}

Delete a gropu in the organization

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the organization | True |  |
| groupname | path | The groupname | True |  |

##### /organization/{name}/group/{groupname}/{username}

###### PUT /organization/{name}/group/{groupname}/{username}

Updates or adds a username to the group

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Group added sucessfully |  |
| 404 | The organization or group could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the group | True |  |
| groupname | path | The groupname | True |  |
| username | path | The username | True |  |

#### organization.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: defined  
 title: Organization  
 description: |-  
   
 An important concept in many services is the management of a group  
 of users in an organization. Within an organization we distinguish  
 different Groups of users and within a Group we can have different roles  
 users can fulfill. Such groups and rols can be used to specify access  
 rights to services.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /organization:  
 get:  
 tags:  
 - Organization  
 summary: Returns a list of organizations  
 description: Returns a list of all organizations  
 operationId: cloudmesh.organization.list  
 responses:  
 '200':  
 description: The list of organizations  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Organization'  
 '400':  
 description: No Organizations found.  
 put:  
 tags:  
 - Organization  
 summary: Uploads an organization to the list of organizations  
 description: Uploads an organization to the list of organizations  
 operationId: cloudmesh.organization.add  
 requestBody:  
 description: The organization to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Organization'  
 responses:  
 '200':  
 description: Organization updated.  
 '400':  
 description: Error updateing Organization.  
 /organization/{name}:  
 get:  
 tags:  
 - Organization  
 summary: Returns the named organization  
 description: Returns an organization by name  
 operationId: cloudmesh.organization.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the organization  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Organization'  
 '400':  
 description: No organization found.  
 '404':  
 description: The named organization could not be found.  
 delete:  
 tags:  
 - Organization  
 summary: Deletes the named organization  
 description: Deletes an organization by name  
 operationId: cloudmesh.organization.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the organization  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Organization found.  
 '404':  
 description: The named organization could not be found.  
 /organization/{name}/user:  
 get:  
 tags:  
 - Organization  
 summary: Returns all users of the organization  
 description: Returns all users of the organization  
 operationId: cloudmesh.organization.user.list  
 responses:  
 '200':  
 description: organization info  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Organization"  
 /organization/{name}/user/{username}:  
 get:  
 tags:  
 - Organization  
 summary: Returns the specific user of that organization  
 description: Returns the specific user of that organization  
 operationId: cloudmesh.organization.user.get\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the organization  
 - name: username  
 description: The username  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: organization info  
 content:  
 application/json:  
 schema:  
 $ref: "user.yaml#/components/schemas/User"  
 put:  
 tags:  
 - Organization  
 summary: Updates or adds a user in the organization  
 description: Updates or adds a user in the organization  
 operationId: cloudmesh.organization.user.add  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the organization  
 requestBody:  
 description: The user to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: 'user.yaml#/components/schemas/User'  
 responses:  
 '200':  
 description: User added sucessfully  
 delete:  
 tags:  
 - Organization  
 summary: Delete an user in the organization  
 description: Delete an user in the organization  
 operationId: cloudmesh.organization.user.delete  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the organization  
 - name: username  
 description: The username  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: Deletion successful.  
 /organization/{name}/group/:  
 get:  
 tags:  
 - Organization  
 summary: Returns all group names  
 description: Returns all group names  
 operationId: cloudmesh.organization.group.list  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 type: array  
 items:  
 type: string  
 '400':  
 description: No group found.  
 '404':  
 description: The named group could not be found.  
 /organization/{name}/group/{groupname}:  
 get:  
 tags:  
 - Organization  
 summary: Returns the specific group of that organization  
 description: Returns the specific group of that organization  
 operationId: cloudmesh.organization.group.get\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the organization  
 - name: groupname  
 description: The groupname  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: organization info  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Group"  
 put:  
 tags:  
 - Organization  
 summary: Updates or adds a group in the organization  
 description: Updates or adds a group in the organization  
 operationId: cloudmesh.organization.group.add  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the group  
 - name: groupname  
 description: The groupname  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: Group added sucessfully  
 delete:  
 tags:  
 - Organization  
 summary: Delete a group in the organization  
 description: Delete a gropu in the organization  
 operationId: cloudmesh.organization.greop.delete  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the organization  
 - name: groupname  
 description: The groupname  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: Deletion successful.  
 /organization/{name}/group/{groupname}/{username}:  
 put:  
 tags:  
 - Organization  
 summary: Updates or adds a username to the group  
 description: Updates or adds a username to the group  
 operationId: cloudmesh.organization.group.user.add  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the group  
 - name: groupname  
 description: The groupname  
 in: path  
 required: true  
 schema:  
 type: string  
 - name: username  
 description: The username  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: Group added sucessfully  
 '404':  
 description: The organization or group could not be found.  
components:  
 schemas:  
 Organization:  
 type: object  
 properties:  
 name:  
 description: Name of the organization  
 type: string  
 users:  
 description: list of users  
 type: array  
 items:  
 $ref: "user.yaml#/components/schemas/User"  
 Group:  
 type: object  
 description: the groups  
 properties:  
 name:  
 type: string  
 description: The name of the group  
 description:  
 type: string  
 description: The description of the group  
 users:  
 description: The user names that are member of the group  
 type: array  
 items:  
 type: string

### User

Services need to specify which users have access to them. User information can be reused in other services and organized in a virtual organization. User can be added to a named list of users. be added, removed, and listed. A group associated with the user can be used to augment users to be part of one or more groups.

We distingush therefor the following Terminology

* *Group*: A user can be part of a group.
* *Organization*: An organization the user belongs to.

To which a user can be added.

#### Schema User

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/user.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| username | string | The unique username associated with the user |
| firstname | string | The firstanme of the user |
| lastname | string | The lastname of the user |
| email | string | The email of the user |
| comment | string | A comment regarding the user |
| publickey | string | The public key of the user |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /user | Returns a list of users |
| put | /user | Uploads a user to the list of users |
| get | /user/{name} | Returns the named user |
| delete | /user/{name} | Deletes the named user |

##### /user

###### GET /user

Returns a list of all users

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of users |  |
| 400 | No Users found. |  |

###### PUT /user

Uploads a user to the list of users

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | User updated. |  |
| 400 | Error updateing User. |  |

##### /user/{name}

###### GET /user/{name}

Returns an user by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No user found. |  |
| 404 | The named user could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the user | True |  |

###### DELETE /user/{name}

Deletes an user by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No User found. |  |
| 404 | The named user could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the user | True |  |

#### user.yaml

openapi: "3.0.2"  
info:  
 version: "3.2.0"  
 x-date: 008-06-2019  
 x-status: defined  
 title: User  
 description: |-  
  
 Services need to specify which users have access to them. User  
 information can be reused in other services and organized in a virtual  
 organization. User can be added to a named list of users.  
 be added, removed, and listed. A group associated with the user can be used  
 to augment users to be part of one or more groups.  
  
 We distingush therefor the following Terminology  
  
 \* \*Group\*: A user can be part of a group.  
 \* \*Organization\*: An organization the user belongs to.  
  
 To which a user can be added.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: Cloudmesh User  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /user:  
 get:  
 tags:  
 - User  
 summary: Returns a list of users  
 description: Returns a list of all users  
 operationId: cloudmesh.user.list  
 responses:  
 '200':  
 description: The list of users  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/User'  
 '400':  
 description: No Users found.  
 put:  
 tags:  
 - User  
 summary: Uploads a user to the list of users  
 description: Uploads a user to the list of users  
 operationId: cloudmesh.user.add  
 requestBody:  
 description: The user to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/User'  
 responses:  
 '200':  
 description: User updated.  
 '400':  
 description: Error updateing User.  
 /user/{name}:  
 get:  
 tags:  
 - User  
 summary: Returns the named user  
 description: Returns an user by name  
 operationId: cloudmesh.user.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the user  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/User'  
 '400':  
 description: No user found.  
 '404':  
 description: The named user could not be found.  
 delete:  
 tags:  
 - User  
 summary: Deletes the named user  
 description: Deletes an user by name  
 operationId: cloudmesh.user.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the user  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No User found.  
 '404':  
 description: The named user could not be found.  
components:  
 schemas:  
 User:  
 type: object  
 properties:  
 username:  
 type: string  
 description: The unique username associated with the user  
 firstname:  
 type: string  
 description: The firstanme of the user  
 lastname:  
 type: string  
 description: The lastname of the user  
 email:  
 type: string  
 description: The email of the user  
 comment:  
 type: string  
 description: A comment regarding the user  
 publickey:  
 type: string  
 description: The public key of the user

### Public Key Store

Many services and frameworks use Secure Shell (SSH) keys to authenticate. This service allows the convenient storage of the public keys.

#### Schema Key

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/key.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | The name of the public key |
| value | string | The value of the public key |
| kind | string | The key kind such as rsa, dsa |
| group | string | An optional group name allowing to group keys to create custom groups |
| comment | string | A comment for the public key |
| uri | string | The uri of the public key if any |
| fingerprint | string | The fingerprint of the public key |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /key | Returns a list of keys |
| put | /key | Set a key |
| get | /key/{name} | Returns the named key |
| delete | /key/{name} | Deletes the named key |

##### /key

###### GET /key

Returns a list of all keys

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of keys |  |
| 400 | No Key found. |  |

###### PUT /key

Sets the named key

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Key updated. |  |
| 400 | Error updateing key. |  |

##### /key/{name}

###### GET /key/{name}

Returns a key by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the key |  |
| 400 | No Key found. |  |
| 404 | The named key could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the key | True |  |

###### DELETE /key/{name}

Deletes a key by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Key found. |  |
| 404 | The named key could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the key | True |  |

#### publickeystore.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: defined  
 title: Public Key Store  
 description: |-  
   
 Many services and frameworks use Secure Shell (SSH) keys to  
 authenticate. This service allows the convenient storage of the  
 public keys.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /key:  
 get:  
 tags:  
 - Key  
 summary: Returns a list of keys  
 description: Returns a list of all keys  
 operationId: cloudmesh.key.list  
 responses:  
 '200':  
 description: The list of keys  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Key'  
 '400':  
 description: No Key found.  
 put:  
 tags:  
 - Key  
 summary: Set a key  
 description: Sets the named key  
 operationId: cloudmesh.key.add  
 requestBody:  
 description: The new key to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Key'  
 responses:  
 '200':  
 description: Key updated.  
 '400':  
 description: Error updateing key.  
 /key/{name}:  
 get:  
 tags:  
 - Key  
 summary: Returns the named key  
 description: Returns a key by name  
 operationId: cloudmesh.key.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the key  
 responses:  
 '200':  
 description: Retruning the information of the key  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Key'  
 '400':  
 description: No Key found.  
 '404':  
 description: The named key could not be found.  
 delete:  
 tags:  
 - Key  
 summary: Deletes the named key  
 description: Deletes a key by name  
 operationId: cloudmesh.key.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the key  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Key found.  
 '404':  
 description: The named key could not be found.  
components:  
 schemas:  
 Key:  
 type: object  
 description: the public key  
 properties:  
 name:  
 type: string  
 description: The name of the public key  
 value:  
 type: string  
 description: The value of the public key  
 kind:  
 type: string  
 description: The key kind such as rsa, dsa  
 group:  
 type: string  
 description: An optional group name allowing to group keys to create  
 custom groups  
 comment:  
 type: string  
 description: A comment for the public key  
 uri:  
 type: string  
 description: The uri of the public key if any  
 fingerprint:  
 type: string  
 description: The fingerprint of the public key

## General Resources

### Timestamp

Data often needs to be timestamped to indicate when it has been accessed, created, or modified. All objects defined in this document will have, in their final version, a timestamp. The date-time string is defined in [RFC3339](https://xml2rfc.ietf.org/public/rfc/html/rfc3339.html#anchor14).

#### Schema Timestamp

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/timestamp.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| accessed | string | The time stamp when the object was last accessed |
| created | string | The time stamp when the object was created |
| modified | string | The time stamp when the object was modified |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /timestamp | Returns the time |

##### /timestamp

###### GET /timestamp

Returns the time to be used in a timestamp

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | the current time and date |  |

#### timestamp.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Timestamp  
 description: |-  
   
 Data often needs to be timestamped to indicate when it has been  
 accessed, created, or modified. All objects defined in this  
 document will have, in their final version, a timestamp.  
 The date-time string is defined in  
 [RFC3339](https://xml2rfc.ietf.org/public/rfc/html/rfc3339.html#anchor14).  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /timestamp:  
 get:  
 summary: Returns the time  
 description: Returns the time to be used in a timestamp  
 responses:  
 '200':  
 description: the current time and date  
 content:  
 text/plain:  
 schema:  
 type: string  
 example: 1985-04-12T23:20:50.52Z  
components:  
 schemas:  
 Timestamp:  
 type: object  
 description: the timestamp  
 properties:  
 accessed:  
 type: string  
 format: date-time  
 description: The time stamp when the object was last accessed  
 example: 1985-04-12T23:20:50.52Z  
 created:  
 type: string  
 format: date-time  
 description: The time stamp when the object was created  
 example: 1985-04-12T23:20:50.52Z  
 modified:  
 type: string  
 format: date-time  
 description: The time stamp when the object was modified  
 example: 1985-04-12T23:20:50.52Z

### Alias

Often a user has the desire to create a custom name for an object. An alias allows to do that while while assosication auser defined name or *alias* to a previouly used name. The aliases could be shared with other users. A name could have one or more aliases.

#### Schema Alias

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/alias.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | The name of the alias |
| source | string | The original object name |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /alias | Returns a list of aliases |
| put | /alias | Set an alias |
| get | /alias/{name} | Returns the named alias |
| delete | /alias/{name} | Deletes the named alias |

##### /alias

###### GET /alias

Returns a list of all aliases

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of aliasses |  |
| 400 | No Alias found. |  |

###### PUT /alias

Sets the named alias

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Alias updated. |  |
| 400 | Error updateing alias. |  |

##### /alias/{name}

###### GET /alias/{name}

Returns an alias by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No Alias found. |  |
| 404 | The named alias could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the alias | True |  |

###### DELETE /alias/{name}

Deletes an alias by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Alias found. |  |
| 404 | The named alias could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the alias | True |  |

#### alias.yaml

openapi: '3.0.2'  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: defined  
 title: Alias  
 description: |-  
  
 Often a user has the desire to create a custom name for an object. An  
 alias allows to do that while while assosication auser defined name or  
 \*alias\* to a previouly used name. The aliases could be shared with other  
 users. A name could have one or more aliases.  
  
 termsOfService: 'https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt'  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /alias:  
 get:  
 tags:  
 - Alias  
 summary: Returns a list of aliases  
 description: Returns a list of all aliases  
 operationId: cloudmesh.alias.list  
 responses:  
 '200':  
 description: The list of aliasses  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Alias'  
 '400':  
 description: No Alias found.  
 put:  
 tags:  
 - Alias  
 summary: Set an alias  
 description: Sets the named alias  
 operationId: cloudmesh.alias.add  
 requestBody:  
 description: The new alias to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Alias'  
 responses:  
 '200':  
 description: Alias updated.  
 '400':  
 description: Error updateing alias.  
 /alias/{name}:  
 get:  
 tags:  
 - Alias  
 summary: Returns the named alias  
 description: Returns an alias by name  
 operationId: cloudmesh.alias.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the alias  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Alias'  
 '400':  
 description: No Alias found.  
 '404':  
 description: The named alias could not be found.  
 delete:  
 tags:  
 - Alias  
 summary: Deletes the named alias  
 description: Deletes an alias by name  
 operationId: cloudmesh.alias.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the alias  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Alias found.  
 '404':  
 description: The named alias could not be found.  
components:  
 schemas:  
 Alias:  
 type: object  
 description: the alias  
 properties:  
 name:  
 type: string  
 description: The name of the alias  
 source:  
 type: string  
 description: The original object name

### Variables

Variables a simple string key value storage to store simple values. Each variable can have a datatype, so that it can be used for serialization into other formats.

#### Schema Variable

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/variable.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the variable |
| value | string | type of the variable |
| description | string | a descriptionof the variable |
| datatype | string | The data type of the variable which can be used for serialization |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /variable | Returns a list of variables |
| put | /variable | Set a variable |
| get | /variable/{name} | Returns the named variable |
| delete | /variable/{name} | Deletes the named variable |

##### /variable

###### GET /variable

Returns a list of all variables

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of variables |  |
| 400 | No Variable found. |  |

###### PUT /variable

Sets the named variable

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Variable updated. |  |
| 400 | Error updateing variable. |  |

##### /variable/{name}

###### GET /variable/{name}

Returns a variable by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the variable |  |
| 400 | No Variable found. |  |
| 404 | The named variable could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the variable | True |  |

###### DELETE /variable/{name}

Deletes a variable by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Variable found. |  |
| 404 | The named variable could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the variable | True |  |

#### variables.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: defined  
 title: Variables  
 description: |-  
   
 Variables a simple string key value storage to store simple  
 values. Each variable can have a datatype, so that it can be used for  
 serialization into other formats.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /variable:  
 get:  
 tags:  
 - Variable  
 summary: Returns a list of variables  
 description: Returns a list of all variables  
 operationId: cloudmesh.variable.list  
 responses:  
 '200':  
 description: The list of variables  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Variable'  
 '400':  
 description: No Variable found.  
 put:  
 tags:  
 - Variable  
 summary: Set a variable  
 description: Sets the named variable  
 operationId: cloudmesh.variable.add  
 requestBody:  
 description: The new variable to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Variable'  
 responses:  
 '200':  
 description: Variable updated.  
 '400':  
 description: Error updateing variable.  
 /variable/{name}:  
 get:  
 tags:  
 - Variable  
 summary: Returns the named variable  
 description: Returns a variable by name  
 operationId: cloudmesh.variable.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the variable  
 responses:  
 '200':  
 description: Retruning the information of the variable  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Variable'  
 '400':  
 description: No Variable found.  
 '404':  
 description: The named variable could not be found.  
 delete:  
 tags:  
 - Variable  
 summary: Deletes the named variable  
 description: Deletes a variable by name  
 operationId: cloudmesh.variable.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the variable  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Variable found.  
 '404':  
 description: The named variable could not be found.  
components:  
 schemas:  
 Variable:  
 type: object  
 description: the variables  
 properties:  
 name:  
 type: string  
 description: name of the variable  
 value:  
 type: string  
 description: type of the variable  
 description:  
 type: string  
 description: a descriptionof the variable  
 datatype:  
 type: string  
 description: The data type of the variable which can be used for serialization

### Default

A default is a special variable that has a context associated with it. This allows one to define values that can be easily retrieved based on the associated context. For example, a default could be the image name for a cloud where the context is defined by the cloud name. In addition to the context, the service name is also specified since a service could have multiple contexts. To be able to define the kind of service there is also a kind attribute.

#### Schema Default

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/default.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | The name of the default |
| value | string | The value of the default |
| context | string | The context of the default |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /default | Returns a list of defaults |
| put | /default | Set a default |
| get | /default/{name} | Returns the named default |
| delete | /default/{name} | Deletes the named default |

##### /default

###### GET /default

Returns a list of all defaults

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of defaults |  |
| 400 | No Default found. |  |

###### PUT /default

Sets the named default

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Default updated. |  |
| 400 | Error updateing default. |  |

##### /default/{name}

###### GET /default/{name}

Returns a default by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the default |  |
| 400 | No Default found. |  |
| 404 | The named default could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the default | True |  |

###### DELETE /default/{name}

Deletes a default by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Default found. |  |
| 404 | The named default could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the default | True |  |

#### default.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: defined  
 title: Default  
 description: |-  
   
 A default is a special variable that has a context associated with  
 it. This allows one to define values that can be easily retrieved  
 based on the associated context. For example, a default could be  
 the image name for a cloud where the context is defined by the  
 cloud name. In addition to the context, the service name is also specified  
 since a service could have multiple contexts. To be able to  
 define the kind of service there is also a kind attribute.  
   
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /default:  
 get:  
 tags:  
 - Default  
 summary: Returns a list of defaults  
 description: Returns a list of all defaults  
 operationId: cloudmesh.default.list  
 responses:  
 '200':  
 description: The list of defaults  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Default'  
 '400':  
 description: No Default found.  
 put:  
 tags:  
 - Default  
 summary: Set a default  
 description: Sets the named default  
 operationId: cloudmesh.default.add  
 requestBody:  
 description: The new default to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Default'  
 responses:  
 '200':  
 description: Default updated.  
 '400':  
 description: Error updateing default.  
 /default/{name}:  
 get:  
 tags:  
 - Default  
 summary: Returns the named default  
 description: Returns a default by name  
 operationId: cloudmesh.default.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the default  
 responses:  
 '200':  
 description: Retruning the information of the default  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Default'  
 '400':  
 description: No Default found.  
 '404':  
 description: The named default could not be found.  
 delete:  
 tags:  
 - Default  
 summary: Deletes the named default  
 description: Deletes a default by name  
 operationId: cloudmesh.default.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the default  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Default found.  
 '404':  
 description: The named default could not be found.  
components:  
 schemas:  
 Default:  
 type: object  
 description: the defaults  
 properties:  
 name:  
 type: string  
 description: The name of the default  
 example: "image"  
 value:  
 type: string  
 description: The value of the default  
 example: "m1.medium"  
 context:  
 type: string  
 description: The context of the default  
 example: "cloud.vm.flavor"

## Data Management

### Filestore

A filestore is a resource allowing storage of data as a traditional file. Instead of using the name filestore we simply use the name file. A file store can contanin any number of files with additional attributes describing the file. An file store is typically located on the same cloud services. This contrasts virtual directories that are just pointers to files, which could include files located in file stores.

#### Schema File

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/file.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | The name of the file |
| endpoint | string | The location of the file |
| checksum | string | The checksum of the file |
| size | integer | The size of the file in byte |
| content | string | the content of the file |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /file | Returns a list of files in the filestore |
| put | /file | Uploads a file to the list of files in the file store |
| get | /file/{name} | Returns the named file in the filestore |
| delete | /file/{name} | Deletes the named file in the file store |

##### /file

###### GET /file

Returns a list of all files

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of files |  |
| 400 | No Files found. |  |

###### PUT /file

Uploads a file to the list of files in the filestore

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | File updated. |  |
| 400 | Error updateing File. |  |

##### /file/{name}

###### GET /file/{name}

Returns an file by name in the filestore

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No file found. |  |
| 404 | The named file could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the file | True |  |

###### DELETE /file/{name}

Deletes an file by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No File found. |  |
| 404 | The named file could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the file | True |  |

#### filestore.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: File  
 description: |-  
   
 A filestore is a resource allowing storage of data as a traditional file.  
 Instead of using the name filestore we simply use the name file.  
 A file store can contanin any number of files with additional attributes  
 describing the file. An file store is typically located on the same cloud  
 services. This contrasts virtual directories that are just pointers to  
 files, which could include files located in file stores.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /file:  
 get:  
 tags:  
 - File  
 summary: Returns a list of files in the filestore  
 description: Returns a list of all files  
 operationId: cloudmesh.file.list  
 responses:  
 '200':  
 description: The list of files  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/File'  
 '400':  
 description: No Files found.  
 put:  
 tags:  
 - File  
 summary: Uploads a file to the list of files in the file store  
 description: Uploads a file to the list of files in the filestore  
 operationId: cloudmesh.file.add  
 requestBody:  
 description: The file to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/File'  
  
  
 responses:  
 '200':  
 description: File updated.  
 '400':  
 description: Error updateing File.  
  
 /file/{name}:  
 get:  
 tags:  
 - File  
 summary: Returns the named file in the filestore  
 description: Returns an file by name in the filestore  
 operationId: cloudmesh.file.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the file  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/File'  
 '400':  
 description: No file found.  
 '404':  
 description: The named file could not be found.  
 delete:  
 tags:  
 - File  
 summary: Deletes the named file in the file store  
 description: Deletes an file by name  
 operationId: cloudmesh.file.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the file  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No File found.  
 '404':  
 description: The named file could not be found.  
components:  
 schemas:  
 File:  
 type: object  
 description: an object representing a file  
 properties:  
 name:  
 type: string  
 description: The name of the file  
 endpoint:  
 type: string  
 description: The location of the file  
 checksum:  
 type: string  
 description: The checksum of the file  
 size:  
 type: integer  
 description: The size of the file in byte  
 content:  
 type: string  
 format: binary  
 description: the content of the file

### Replica

In many distributed systems, it is important that a file can be replicated among different systems to provide faster access. It is important to provide a mechanism to trace the pedigree of the file while pointing to its original source.

#### Schema Replica

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/replica.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | the name of the replica |
| filename | string | the original filename |
| endpoint | string | The location of the file |
| checksum | string | The checksum of the file |
| size | integer | The size of the file in byte |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /replica | Returns a list of replicas |
| put | /replica | Uploads a replica to the list of replicas |
| get | /replica/{name} | Returns the named replica |
| delete | /replica/{name} | Deletes the named replica |

##### /replica

###### GET /replica

Returns a list of all replicas

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of replicas |  |
| 400 | No Replicas found. |  |

###### PUT /replica

Uploads a replica to the list of replicas

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Replica updated. |  |
| 400 | Error updateing Replica. |  |

##### /replica/{name}

###### GET /replica/{name}

Returns an replica by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No replica found. |  |
| 404 | The named replica could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the replica | True |  |

###### DELETE /replica/{name}

Deletes an replica by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Replica found. |  |
| 404 | The named replica could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the replica | True |  |

#### replica.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Replica  
 description: |-  
   
 In many distributed systems, it is important that a file can be  
 replicated among different systems to provide faster access. It is  
 important to provide a mechanism to trace the pedigree of the file  
 while pointing to its original source.   
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /replica:  
 get:  
 tags:  
 - Replica  
 summary: Returns a list of replicas  
 description: Returns a list of all replicas  
 operationId: cloudmesh.replica.list  
 responses:  
 '200':  
 description: The list of replicas  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Replica'  
 '400':  
 description: No Replicas found.  
 put:  
 tags:  
 - Replica  
 summary: Uploads a replica to the list of replicas  
 description: Uploads a replica to the list of replicas  
 operationId: cloudmesh.replica.add  
 requestBody:  
 description: The replica to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Replica'  
 responses:  
 '200':  
 description: Replica updated.  
 '400':  
 description: Error updateing Replica.  
 /replica/{name}:  
 get:  
 tags:  
 - Replica  
 summary: Returns the named replica  
 description: Returns an replica by name  
 operationId: cloudmesh.replica.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the replica  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Replica'  
 '400':  
 description: No replica found.  
 '404':  
 description: The named replica could not be found.  
 delete:  
 tags:  
 - Replica  
 summary: Deletes the named replica  
 description: Deletes an replica by name  
 operationId: cloudmesh.replica.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the replica  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Replica found.  
 '404':  
 description: The named replica could not be found.  
components:  
 schemas:  
 Replica:  
 type: object  
 description: An entry representing a file replica record  
 properties:  
 name:  
 type: string  
 description: the name of the replica  
 filename:  
 type: string  
 description: the original filename  
 endpoint:  
 type: string  
 description: The location of the file  
 checksum:  
 type: string  
 description: The checksum of the file  
 size:  
 type: integer  
 description: The size of the file in byte

### Database

The database specification allows to register a database and perform elementary operations to use this database. We distinguish actions related to the registration, the adding of a schema, the insertion of data and the query of data. The data base is defined by a name an endpoint (e.g., host, port), and a protocol used (e.g., SQL, MongoDB, graphgl, and others).

#### Schema Database

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/database.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the database |
| description | string | description of the database |
| endpoint | string | endpoint of the database |
| kind | string | the kind of the database |
| timestamp |  | timestamps associated with the resource |

#### Schema Definition

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/definition.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the database |
| description | string | description of the database |
| kind | string | the kind of the definition |
| schema | string | the schema associated with the table or collection |
| timestamp |  | timestamps associated with the resource |

#### Schema Record

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/record.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| status | string | The status of the reurn |
| result | string | The result of the quesry in json string format |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /database | Returns all databases |
| delete | /database | Deletes a database from the list of databases |
| get | /database/{name} | Get the list of tables or collections for the database |
| put | /database/{name} | Upload a news table or collection |
| get | /database/{name}/{table\_or\_collection} | Query the table or collection |
| put | /database/{name}/{table\_or\_collection} | add data to the table or collection |

##### /database

###### GET /database

Returns all databases

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | database info |  |
| 400 | Invalid name supplied |  |
| 401 | Invalid credentials |  |
| 404 | Database not found |  |

###### DELETE /database

Deletes a database from the list of databases

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | database info |  |
| 400 | Invalid name supplied |  |
| 404 | Database Information not found |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | name of the database | True |  |

##### /database/{name}

###### GET /database/{name}

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | successfully returned the list |  |
| 400 | Invalid name supplied |  |
| 401 | Invalid credentials |  |
| 405 | Invalid input |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | name of the collections or tables | True |  |

###### PUT /database/{name}

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | successfully returned the list |  |
| 400 | Invalid name supplied |  |
| 401 | Invalid credentials |  |
| 405 | Invalid input |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | name of the collections or tables | True |  |

##### /database/{name}/{table\_or\_collection}

###### GET /database/{name}/{table\_or\_collection}

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | successfully ran the Query |  |
| 400 | Invalid name supplied |  |
| 401 | Invalid credentials |  |
| 405 | Invalid input |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | name of the database | True |  |
| table\_or\_collection | path | name of the table or collection | True |  |
| query | query | Database Query | True |  |

###### PUT /database/{name}/{table\_or\_collection}

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | successfully uploaded |  |
| 400 | Invalid name supplied |  |
| 401 | Invalid credentials |  |
| 405 | Invalid input |  |
| 404 | Invalid database name or table or collection name supplied |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | name of the database | True |  |
| table\_or\_collection | path | name of the table or collection | True |  |
| record | path | Information to be uploaded | True |  |

#### database.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Database  
 description: |-  
  
 The database specification allows to register a database and perform  
 elementary operations to use this database. We distinguish actions  
 related to the registration, the adding of a schema, the insertion of  
 data and the query of data. The data base is defined by a name an endpoint  
 (e.g., host, port), and a protocol used (e.g., SQL, MongoDB, graphgl, and  
 others).  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /database:  
 get:  
 tags:  
 - "Database Registry"  
 summary: Returns all databases  
 description: Returns all databases  
 operationId: cloudmesh.database.get  
 responses:  
 '200':  
 description: database info  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: "#/components/schemas/Database"  
 '400':  
 description: "Invalid name supplied"  
 '401':  
 description: "Invalid credentials"  
 '404':  
 description: "Database not found"  
 delete:  
 tags:  
 - "Database Registry"  
 summary: Deletes a database from the list of databases  
 description: Deletes a database from the list of databases  
 operationId: cloudmesh.database.delete  
 parameters:  
 - name: name  
 description: name of the database  
 in: path  
 required: true  
 type: string  
 responses:  
 '200':  
 description: database info  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Database"  
 '400':  
 description: "Invalid name supplied"  
 '404':  
 description: "Database Information not found"  
 /database/{name}:  
 get:  
 tags:  
 - "Database Definition"  
 summary: "Get the list of tables or collections for the database"  
 description: ""  
 operationId: "cloudmesh.database.get.collections\_or\_tables"  
 parameters:  
 - name: name  
 description: name of the collections or tables  
 in: path  
 required: true  
 type: string  
 responses:  
 '200':  
 description: "successfully returned the list"  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: "#/components/schemas/Definition"  
 '400':  
 description: "Invalid name supplied"  
 '401':  
 description: "Invalid credentials"  
 '405':  
 description: "Invalid input"  
 put:  
 tags:  
 - "Database Definition"  
 summary: "Upload a news table or collection"  
 description: ""  
 operationId: "cloudmesh.database.put.collections\_or\_tables"  
 parameters:  
 - name: name  
 description: name of the collections or tables  
 in: path  
 required: true  
 type: string  
 responses:  
 '200':  
 description: "successfully returned the list"  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Definition"  
 '400':  
 description: "Invalid name supplied"  
 '401':  
 description: "Invalid credentials"  
 '405':  
 description: "Invalid input"  
 /database/{name}/{table\_or\_collection}:  
 get:  
 tags:  
 - "Database Data Interaction"  
 summary: "Query the table or collection"  
 description: ""  
 operationId: "cloudmesh.database.data.get"  
 parameters:  
 - name: name  
 description: name of the database  
 in: path  
 required: true  
 type: string  
 - name: table\_or\_collection  
 description: name of the table or collection  
 in: path  
 required: true  
 type: string  
 - name: "query"  
 in: "query"  
 description: "Database Query"  
 required: true  
 type: "string"  
 format: base64  
 responses:  
 '200':  
 description: "successfully ran the Query"  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: "#/components/schemas/Record"  
 '400':  
 description: "Invalid name supplied"  
 '401':  
 description: "Invalid credentials"  
 '405':  
 description: "Invalid input"  
 put:  
 tags:  
 - "Database Data Interaction"  
 summary: "add data to the table or collection"  
 description: ""  
 operationId: "cloudmesh.database.data.put"  
 parameters:  
 - name: name  
 description: name of the database  
 in: path  
 required: true  
 type: string  
 - name: table\_or\_collection  
 description: name of the table or collection  
 in: path  
 required: true  
 type: string  
 - name: record  
 in: path  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Record"  
 description: "Information to be uploaded"  
 required: true  
 responses:  
 '200':  
 description: "successfully uploaded"  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Record"  
 '400':  
 description: "Invalid name supplied"  
 '401':  
 description: "Invalid credentials"  
 '405':  
 description: "Invalid input"  
 '404':  
 description: "Invalid database name or table or collection name supplied"  
  
components:  
 schemas:  
 Database:  
 type: object  
 description: defines a database object as an entry  
 properties:  
 name:  
 type: string  
 description: name of the database  
 description:  
 type: string  
 description: description of the database  
 endpoint:  
 type: string  
 description: endpoint of the database  
 kind:  
 type: string  
 description: the kind of the database  
 timestamp:  
 description: timestamps associated with the resource  
 $ref: "timestamp.yaml#/components/schemas/Timestamp"  
 Definition:  
 type: object  
 description: defines a database collection or Table  
 properties:  
 name:  
 type: string  
 description: name of the database  
 description:  
 type: string  
 description: description of the database  
 kind:  
 type: string  
 description: the kind of the definition  
 schema:  
 type: string  
 description: the schema associated with the table or collection  
 timestamp:  
 description: timestamps associated with the resource  
 $ref: "timestamp.yaml#/components/schemas/Timestamp"  
 Record:  
 type: object  
 description: The result of a query  
 properties:  
 status:  
 type: string  
 description: The status of the reurn  
 result:  
 type: string  
 description: The result of the quesry in json string format

### Virtual Directory

A virtual directory is a collection of files, replicas, streams or other virtual directories.

#### Schema Virtualdirectory

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/virtualdirectory.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | The name of the virtual directory |
| description | string | description of the virtual directory |
| host | string | remote host of the virtual directory |
| location | string | remote location, e.g., a directory with full path on a host |
| protocol | string | access protocol, e.g., HTTP, FTP, SSH, etc. |
| credential | object | credential to access, e.g., username, password |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /virtualdirectory | Returns a list of virtualdirectorys |
| put | /virtualdirectory | Uploads a virtualdirectory to the list of virtualdirectorys |
| get | /virtualdirectory/{name} | Returns the named virtualdirectory |
| delete | /virtualdirectory/{name} | Deletes the named virtualdirectory |
| get | /virtualdirectory/{name}/{filename} | Returns the specific file of that virtualdirectory |
| put | /virtualdirectory/{name}/{filename} | Updates or adds a virtual file in the virtualdirectory |
| delete | /virtualdirectory/{name}/{filename} | Delete an user in the virtualdirectory |

##### /virtualdirectory

###### GET /virtualdirectory

Returns a list of all virtualdirectorys

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of virtualdirectorys |  |
| 400 | No Virtualdirectorys found. |  |

###### PUT /virtualdirectory

Uploads a virtualdirectory to the list of virtualdirectorys

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Virtualdirectory updated. |  |
| 400 | Error updateing Virtualdirectory. |  |

##### /virtualdirectory/{name}

###### GET /virtualdirectory/{name}

Returns an virtualdirectory by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No virtualdirectory found. |  |
| 404 | The named virtualdirectory could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualdirectory | True |  |

###### DELETE /virtualdirectory/{name}

Deletes an virtualdirectory by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Virtualdirectory found. |  |
| 404 | The named virtualdirectory could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualdirectory | True |  |

##### /virtualdirectory/{name}/{filename}

###### GET /virtualdirectory/{name}/{filename}

Returns the specific file of that virtualdirectory

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | upload ok |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualdirectory | True |  |
| filename | path | The filename | True |  |

###### PUT /virtualdirectory/{name}/{filename}

Updates or adds a virtual file in the virtualdirectory

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | User added sucessfully |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualdirectory | True |  |

###### DELETE /virtualdirectory/{name}/{filename}

Delete an user in the virtualdirectory

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualdirectory | True |  |
| username | path | The username | True |  |

#### virtualdirectory.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Virtual Directory  
 description: |-  
   
 A virtual directory is a collection of files, replicas, streams or other  
 virtual directories.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup Service  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /virtualdirectory:  
 get:  
 tags:  
 - Virtualdirectory  
 summary: Returns a list of virtualdirectorys  
 description: Returns a list of all virtualdirectorys  
 operationId: cloudmesh.virtualdirectory.list  
 responses:  
 '200':  
 description: The list of virtualdirectorys  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Virtualdirectory'  
 '400':  
 description: No Virtualdirectorys found.  
 put:  
 tags:  
 - Virtualdirectory  
 summary: Uploads a virtualdirectory to the list of virtualdirectorys  
 description: Uploads a virtualdirectory to the list of virtualdirectorys  
 operationId: cloudmesh.virtualdirectory.add  
 requestBody:  
 description: The virtualdirectory to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Virtualdirectory'  
 responses:  
 '200':  
 description: Virtualdirectory updated.  
 '400':  
 description: Error updateing Virtualdirectory.  
 /virtualdirectory/{name}:  
 get:  
 tags:  
 - Virtualdirectory  
 summary: Returns the named virtualdirectory  
 description: Returns an virtualdirectory by name  
 operationId: cloudmesh.virtualdirectory.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualdirectory  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Virtualdirectory'  
 '400':  
 description: No virtualdirectory found.  
 '404':  
 description: The named virtualdirectory could not be found.  
 delete:  
 tags:  
 - Virtualdirectory  
 summary: Deletes the named virtualdirectory  
 description: Deletes an virtualdirectory by name  
 operationId: cloudmesh.virtualdirectory.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualdirectory  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Virtualdirectory found.  
 '404':  
 description: The named virtualdirectory could not be found.  
  
 /virtualdirectory/{name}/{filename}:  
 get:  
 tags:  
 - Virtualdirectory  
 summary: Returns the specific file of that virtualdirectory  
 description: Returns the specific file of that virtualdirectory  
 operationId: cloudmesh.virtualdirectory.file.get\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualdirectory  
 - name: filename  
 description: The filename  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: upload ok  
 content:  
 application/json:  
 schema:  
 $ref: "filestore.yaml#/components/schemas/File"  
 put:  
 tags:  
 - Virtualdirectory  
 summary: Updates or adds a virtual file in the virtualdirectory  
 description: Updates or adds a virtual file in the virtualdirectory  
 operationId: cloudmesh.virtualdirectory.file.add  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualdirectory  
 requestBody:  
 description: The user to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: "filestore.yaml#/components/schemas/File"  
 responses:  
 '200':  
 description: User added sucessfully  
 delete:  
 tags:  
 - Virtualdirectory  
 summary: Delete an user in the virtualdirectory  
 description: Delete an user in the virtualdirectory  
 operationId: cloudmesh.virtualdirectory.file.delete  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualdirectory  
 - name: username  
 description: The username  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: Deletion successful.  
components:  
 schemas:  
 Virtualdirectory:  
 type: object  
 description: the virtualdirectory  
 properties:  
 name:  
 description: The name of the virtual directory  
 type: string  
 description:  
 description: description of the virtual directory  
 type: string  
 host:  
 description: remote host of the virtual directory  
 type: string  
 location:  
 description: remote location, e.g., a directory with full path on a host  
 type: string  
 protocol:  
 description: access protocol, e.g., HTTP, FTP, SSH, etc.  
 type: string  
 credential:  
 description: credential to access, e.g., username, password  
 type: object

## Compute Management - Virtual Clusters

### Virtual Cluster

A Virtual Cluster is modeled as manager node, and one or more compute nodes. The manager node usually served as a login node and can be accessed from outside via a public IP. The compute nodes are connected to the manager node via a private, usually high performance (high throughput and low latency), network and thus accessible only from the manager node. To use the virtual cluster, you login to the manager node, and from there you can login to any compute node, or submit a job to run on the compute nodes.

#### Schema Virtualcluster

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/virtualcluster.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | The name of the virtual cluster |
| description | string | A description of the virtual cluster |
| owner | string | username of the owner of the virtual cluster |
| manager |  | Manager node of the virtual cluster |
| nodes | array[Node] | List of nodes of the virtual cluster |

#### Schema Node

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/node.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the node |
| state | string | power state of the node |
| ncpu | integer | number of virtual CPUs of the node |
| ram | string | RAM size of the node |
| disk | string | Disk size of the node |
| nics | array[NIC] | List of network interfaces of the node |

#### Schema NIC

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/nic.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| mac | string | MAC address of the node |
| ip | string | IP address of the node |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /virtualcluster | Returns a list of virtualclusters |
| put | /virtualcluster | Uploads an virtualcluster to the list of virtualclusters |
| get | /virtualcluster/{name} | Returns the named virtualcluster |
| delete | /virtualcluster/{name} | Deletes the named virtualcluster |
| get | /virtualcluster/{name}/{nodename} | Node of the named virtualcluster |
| put | /virtualcluster/{name}/{nodename} | Updates or adds a node to the virtualcluster |
| delete | /virtualcluster/{name}/{nodename} | Delete a node in the virtualcluster |

##### /virtualcluster

###### GET /virtualcluster

Returns a list of all virtualclusters

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of virtualclusters |  |
| 400 | No Virtualclusters found. |  |

###### PUT /virtualcluster

Uploads an virtualcluster to the list of virtualclusters

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Virtualcluster updated or created. |  |
| 400 | Error updateing Virtualcluster. |  |

##### /virtualcluster/{name}

###### GET /virtualcluster/{name}

Returns an virtualcluster by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No virtualcluster found. |  |
| 404 | The named virtualcluster could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualcluster | True |  |

###### DELETE /virtualcluster/{name}

Deletes an virtualcluster by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Virtualcluster found. |  |
| 404 | The named virtualcluster could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualcluster | True |  |

##### /virtualcluster/{name}/{nodename}

###### GET /virtualcluster/{name}/{nodename}

Returns the specific node of the named virtualcluster. If the node name is manager, the manager node is used. A compute node can not be named manager

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Node info |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualcluster | True |  |
| nodename | path | The nodename | True |  |

###### PUT /virtualcluster/{name}/{nodename}

Updates or adds a node to the virtualcluster. If the node name is manager, the manager node is uploaded.

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Node added sucessfully |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualcluster | True |  |

###### DELETE /virtualcluster/{name}/{nodename}

Delete a node in the virtualcluster

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the virtualcluster | True |  |
| username | path | The nodename | True |  |

#### virtualcluster.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Virtual Cluster  
 description: |-  
  
 A Virtual Cluster is modeled as manager node, and one or more  
 compute nodes. The manager node usually served as a login node and  
 can be accessed from outside via a public IP. The compute nodes are  
 connected to the manager node via a private, usually high performance (high  
 throughput and low latency), network and thus accessible only from the  
 manager node. To use the virtual cluster, you login to the manager node, and  
 from there you can login to any compute node, or submit a job to run on the  
 compute nodes.  
   
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup Service  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /virtualcluster:  
 get:  
 tags:  
 - Virtualcluster  
 summary: Returns a list of virtualclusters  
 description: Returns a list of all virtualclusters  
 operationId: cloudmesh.virtualcluster.list  
 responses:  
 '200':  
 description: The list of virtualclusters  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Virtualcluster'  
 '400':  
 description: No Virtualclusters found.  
 put:  
 tags:  
 - Virtualcluster  
 summary: Uploads an virtualcluster to the list of virtualclusters  
 description: Uploads an virtualcluster to the list of virtualclusters  
 operationId: cloudmesh.virtualcluster.add  
 requestBody:  
 description: The virtualcluster to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Virtualcluster'  
 responses:  
 '200':  
 description: Virtualcluster updated or created.  
 '400':  
 description: Error updateing Virtualcluster.  
 /virtualcluster/{name}:  
 get:  
 tags:  
 - Virtualcluster  
 summary: Returns the named virtualcluster  
 description: Returns an virtualcluster by name  
 operationId: cloudmesh.virtualcluster.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualcluster  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Virtualcluster'  
 '400':  
 description: No virtualcluster found.  
 '404':  
 description: The named virtualcluster could not be found.  
 delete:  
 tags:  
 - Virtualcluster  
 summary: Deletes the named virtualcluster  
 description: Deletes an virtualcluster by name  
 operationId: cloudmesh.virtualcluster.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualcluster  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Virtualcluster found.  
 '404':  
 description: The named virtualcluster could not be found.  
 /virtualcluster/{name}/{nodename}:  
 get:  
 tags:  
 - Virtualcluster  
 summary: Node of the named virtualcluster  
 description: Returns the specific node of the named virtualcluster. If  
 the node name is manager, the manager node is used. A  
 compute node can not be named manager  
 operationId: cloudmesh.virtualcluster.node.get\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualcluster  
 - name: nodename  
 description: The nodename  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: Node info  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Node"  
 put:  
 tags:  
 - Virtualcluster  
 summary: Updates or adds a node to the virtualcluster  
 description: Updates or adds a node to the virtualcluster. If  
 the node name is manager, the manager node is uploaded.  
 operationId: cloudmesh.virtualcluster.node.add  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualcluster  
 requestBody:  
 description: The node to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Node'  
 responses:  
 '200':  
 description: Node added sucessfully  
 delete:  
 tags:  
 - Virtualcluster  
 summary: Delete a node in the virtualcluster  
 description: Delete a node in the virtualcluster  
 operationId: cloudmesh.virtualcluster.node.delete  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the virtualcluster  
 - name: username  
 description: The nodename  
 in: path  
 required: true  
 schema:  
 type: string  
 responses:  
 '200':  
 description: Deletion successful.  
components:  
 schemas:  
 Virtualcluster:  
 type: object  
 properties:  
 name:  
 description: The name of the virtual cluster  
 type: string  
 description:  
 type: string  
 description: A description of the virtual cluster  
 owner:  
 type: string  
 description: username of the owner of the virtual cluster  
 manager:  
 description: Manager node of the virtual cluster  
 $ref: "#/components/schemas/Node"  
 nodes:  
 description: List of nodes of the virtual cluster  
 type: array  
 items:  
 $ref: "#/components/schemas/Node"  
 Node:  
 type: object  
 properties:  
 name:  
 type: string  
 description: name of the node  
 state:  
 type: string  
 description: power state of the node  
 ncpu:  
 type: integer  
 description: number of virtual CPUs of the node  
 ram:  
 type: string  
 description: RAM size of the node  
 disk:  
 type: string  
 description: Disk size of the node  
 nics:  
 type: array  
 description: List of network interfaces of the node  
 items:  
 $ref: "#/components/schemas/NIC"  
 NIC:  
 type: object  
 properties:  
 mac:  
 type: string  
 description: MAC address of the node  
 ip:  
 type: string  
 description: IP address of the node

### Scheduler

The scheduler is a service to execute tasks based on a scheduling policy. A scheduler returns the next task to be executed. Tasks can be added and deleted.

#### Schema Task

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/task.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the scheduler |
| user | name | the username the task belongs to |
| description | string | The description of the task |
| kind | string | The kind of the task |

#### Schema Policy

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/policy.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the scheduler policy |
| description | string | The description of the policy |
| kind | string | The kind of the policy |
| parameters | string | parameters to define the behaviour of the scheduler |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /task/next | Returns the next tasks and removed it from the list of tasks |
| get | /task/info | Returns information about the task that is to be scheduled next |
| get | /task/pop | Removes the next task to be scheduled, but does not executes it. |
| get | /task | Returns a list of tasks |
| put | /task | Uploads a task to the list of tasks |
| get | /task/{name} | Returns the named task |
| delete | /task/{name} | Deletes the named task |
| get | /policy | Returns the policy |
| put | /policy | Uploads the policy |

##### /task/next

###### GET /task/next

Returns the next task

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The task |  |
| 400 | No Tasks found. |  |

##### /task/info

###### GET /task/info

Returns the next task

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The task |  |
| 400 | No Tasks found. |  |

##### /task/pop

###### GET /task/pop

Returns the next task

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The task |  |
| 400 | No Tasks found. |  |

##### /task

###### GET /task

Returns a list of all tasks

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of tasks |  |
| 400 | No Tasks found. |  |

###### PUT /task

Uploads a task to the list of tasks

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Task updated. |  |
| 400 | Error updateing Task. |  |

##### /task/{name}

###### GET /task/{name}

Returns an task by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No task found. |  |
| 404 | The named task could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the task | True |  |

###### DELETE /task/{name}

Deletes an task by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Task found. |  |
| 404 | The named task could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the task | True |  |

##### /policy

###### GET /policy

Returns the polocy

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The policy |  |
| 400 | No Tasks found. |  |

###### PUT /policy

Uploads a task to the list of tasks

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Task updated. |  |
| 400 | Error updateing Task. |  |

#### scheduler.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Scheduler  
 description: |-  
   
 The scheduler is a service to execute tasks based on a scheduling policy.  
 A scheduler returns the next task to be executed. Tasks can be added and  
 deleted.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3/scheduler  
paths:  
 /task/next:  
 get:  
 tags:  
 - Task  
 summary: Returns the next tasks and removed it from the list of tasks  
 description: Returns the next task  
 operationId: cloudmesh.task.next  
 responses:  
 '200':  
 description: The task  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Task'  
 '400':  
 description: No Tasks found.  
 /task/info:  
 get:  
 tags:  
 - Task  
 summary: Returns information about the task that is to be scheduled next  
 description: Returns the next task  
 operationId: cloudmesh.task.next  
 responses:  
 '200':  
 description: The task  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Task'  
 '400':  
 description: No Tasks found.  
 /task/pop:  
 get:  
 tags:  
 - Task  
 summary: Removes the next task to be scheduled, but does not executes it.  
 description: Returns the next task  
 operationId: cloudmesh.task.next  
 responses:  
 '200':  
 description: The task  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Task'  
 '400':  
 description: No Tasks found.  
  
 /task:  
 get:  
 tags:  
 - Task  
 summary: Returns a list of tasks  
 description: Returns a list of all tasks  
 operationId: cloudmesh.task.list  
 responses:  
 '200':  
 description: The list of tasks  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Task'  
 '400':  
 description: No Tasks found.  
 put:  
 tags:  
 - Task  
 summary: Uploads a task to the list of tasks  
 description: Uploads a task to the list of tasks  
 operationId: cloudmesh.task.add  
 requestBody:  
 description: The task to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Task'  
 responses:  
 '200':  
 description: Task updated.  
 '400':  
 description: Error updateing Task.  
 /task/{name}:  
 get:  
 tags:  
 - Task  
 summary: Returns the named task  
 description: Returns an task by name  
 operationId: cloudmesh.task.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the task  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Task'  
 '400':  
 description: No task found.  
 '404':  
 description: The named task could not be found.  
 delete:  
 tags:  
 - Task  
 summary: Deletes the named task  
 description: Deletes an task by name  
 operationId: cloudmesh.task.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the task  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Task found.  
 '404':  
 description: The named task could not be found.  
 /policy:  
 get:  
 tags:  
 - Task  
 summary: Returns the policy  
 description: Returns the polocy  
 operationId: cloudmesh.task.list  
 responses:  
 '200':  
 description: The policy  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Policy'  
 '400':  
 description: No Tasks found.  
 put:  
 tags:  
 - Task  
 summary: Uploads the policy  
 description: Uploads a task to the list of tasks  
 operationId: cloudmesh.task.add  
 requestBody:  
 description: The task to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Task'  
 responses:  
 '200':  
 description: Task updated.  
 '400':  
 description: Error updateing Task.  
  
components:  
 schemas:  
 Task:  
 type: object  
 description: the scheduler  
 properties:  
 name:  
 type: string  
 description: name of the scheduler  
 user:  
 type: name  
 description: the username the task belongs to  
 description:  
 type: string  
 description: The description of the task  
 kind:  
 type: string  
 description: The kind of the task  
 Policy:  
 type: object  
 description: The policy of the scheduler  
 properties:  
 name:  
 type: string  
 description: name of the scheduler policy  
 description:  
 type: string  
 description: The description of the policy  
 kind:  
 type: string  
 description: The kind of the policy  
 parameters:  
 type: string  
 description: parameters to define the behaviour of the scheduler

## Compute Management - Virtual Machines

This section summarizes a basic interface specification of virtual machines.

### Image

To execute virtual machines, we need an image that specifies the details of the operationg system.

#### Schema Image

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/image.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | A unique name of the image |
| cloud | string | The name of the cloud |
| label | string | A label that can be defined by the user for the image |
| description | string | A description for the image |
| osType | string | The OS type of the image |
| osVersion | string | The OS version of the image |
| status | string | The status of the image |
| progress | integer | The loading progress percentage of the image |
| visibility | string | The visibility of the image |
| requirement |  | Minimum requirement to run the image |

#### Schema Requirements

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/requirements.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| disk\_space | integer | Minimum disk space in bytes required for the image |
| ram | integer | Minimum ram size in bytes to run the image |
| cpu | string | CPU required to run the image |
| cores | integer | Minimum number of cores |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /image/{cloud} | Returns a list of images for the cloud |
| put | /image/{cloud} | Add a image |
| get | /image/{cloud}/{name} | Returns the named image |
| delete | /image/{cloud}/{name} | Deletes the named image |

##### /image/{cloud}

###### GET /image/{cloud}

Returns a list of all images

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of images |  |
| 400 | No Image found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |

###### PUT /image/{cloud}

Sets the named image

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Image updated. |  |
| 400 | Error updateing image. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |

##### /image/{cloud}/{name}

###### GET /image/{cloud}/{name}

Returns a image by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the image |  |
| 400 | No Image found. |  |
| 404 | The named image could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |
| name | path | The name of the image | True |  |

###### DELETE /image/{cloud}/{name}

Deletes a image by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Image found. |  |
| 404 | The named image could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |
| name | path | The name of the image | True |  |

#### image.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Image  
 description: |-  
   
 To execute virtual machines, we need an image that specifies the  
 details of the operationg system.  
   
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /image/{cloud}:  
 get:  
 tags:  
 - Image  
 summary: Returns a list of images for the cloud  
 description: Returns a list of all images  
 operationId: cloudmesh.image.list  
 parameters:  
 - name: cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the cloud  
 responses:  
 '200':  
 description: The list of images  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Image'  
 '400':  
 description: No Image found.  
 put:  
 tags:  
 - Image  
 summary: Add a image  
 description: Sets the named image  
 operationId: cloudmesh.image.add  
 parameters:  
 - name: cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the cloud  
 requestBody:  
 description: The image to add or modify  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Image'  
 responses:  
 '200':  
 description: Image updated.  
 '400':  
 description: Error updateing image.  
 /image/{cloud}/{name}:  
 get:  
 tags:  
 - Image  
 summary: Returns the named image  
 description: Returns a image by name  
 operationId: cloudmesh.image.find\_by\_name  
 parameters:  
 - name: cloud  
 in: path  
 description: The name of the cloud  
 required: true  
 schema:  
 type: string  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the image  
 responses:  
 '200':  
 description: Retruning the information of the image  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Image'  
 '400':  
 description: No Image found.  
 '404':  
 description: The named image could not be found.  
 delete:  
 tags:  
 - Image  
 summary: Deletes the named image  
 description: Deletes a image by name  
 operationId: cloudmesh.image.delete\_by\_name  
 parameters:  
 - name: cloud  
 description: The name of the cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the image  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Image found.  
 '404':  
 description: The named image could not be found.  
components:  
 schemas:  
 Image:  
 type: object  
 properties:  
 name:  
 type: string  
 description: A unique name of the image  
 cloud:  
 type: string  
 description: The name of the cloud  
 label:  
 type: string  
 description: A label that can be defined by the user for the image  
 description:  
 type: string  
 description: A description for the image  
 osType:  
 type: string  
 description: The OS type of the image  
 osVersion:  
 type: string  
 description: The OS version of the image  
 status:  
 type: string  
 description: The status of the image  
 progress:  
 type: integer  
 description: The loading progress percentage of the image  
 visibility:  
 description: The visibility of the image  
 type: string  
 requirement:  
 $ref: "#/components/schemas/Requirements"  
 description: Minimum requirement to run the image  
 Requirements:  
 type: object  
 properties:  
 disk\_space:  
 type: integer  
 description: Minimum disk space in bytes required for the image  
 ram:  
 type: integer  
 description: Minimum ram size in bytes to run the image  
 cpu:  
 type: string  
 description: CPU required to run the image  
 cores:  
 type: integer  
 description: Minimum number of cores

### Flavor

The flavor specifies elementary information about a compute node. This information includes name, id, label, ram size, swap size, disk space, availability of ephemeral disk, available bandwidth, price value, cloud name. Flavors and the corresponding information are essential to size a virtual cluster appropriately.

#### Schema Flavor

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/flavor.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | Name of the flavor |
| id | string | The id of the flavor for the named cloud |
| label | string | A label that a user can set for this flavor |
| description | string | A description for the flavor |
| ram | integer | Number of bytes used for the image in RAM |
| swap | integer | Number of bytes used for the image in SWAP |
| disk | integer | Number of bytes used for the disk |
| ephemeral\_disk | boolean | Specifies whether the flavor features an ephemeral disk |
| bandwidth | integer | Bandwidth of the node |
| price | float | Price for the flavor |
| cloud | string | Name of the cloud this flavor is used in |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /flavor/{cloud} | Returns a list of flavors for the cloud |
| put | /flavor/{cloud} | Add a flavor |
| get | /flavor/{cloud}/{name} | Returns the named flavor |
| delete | /flavor/{cloud}/{name} | Deletes the named flavor |

##### /flavor/{cloud}

###### GET /flavor/{cloud}

Returns a list of all flavors

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of flavors |  |
| 400 | No Flavor found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |

###### PUT /flavor/{cloud}

Sets the named flavor

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Flavor updated. |  |
| 400 | Error updateing flavor. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |

##### /flavor/{cloud}/{name}

###### GET /flavor/{cloud}/{name}

Returns a flavor by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the flavor |  |
| 400 | No Flavor found. |  |
| 404 | The named flavor could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |
| name | path | The name of the flavor | True |  |

###### DELETE /flavor/{cloud}/{name}

Deletes a flavor by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Flavor found. |  |
| 404 | The named flavor could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |
| name | path | The name of the flavor | True |  |

#### flavor.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: defined  
 title: Flavor  
 description: |-  
   
 The flavor specifies elementary information about a compute  
 node. This information includes name, id, label, ram size,  
 swap size, disk space, availability of ephemeral disk, available  
 bandwidth, price value, cloud name. Flavors and the corresponding  
 information are essential to size a  
 virtual cluster appropriately.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /flavor/{cloud}:  
 get:  
 tags:  
 - Flavor  
 summary: Returns a list of flavors for the cloud  
 description: Returns a list of all flavors  
 operationId: cloudmesh.flavor.list  
 parameters:  
 - name: cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the cloud  
 responses:  
 '200':  
 description: The list of flavors  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Flavor'  
 '400':  
 description: No Flavor found.  
 put:  
 tags:  
 - Flavor  
 summary: Add a flavor  
 description: Sets the named flavor  
 operationId: cloudmesh.flavor.add  
 parameters:  
 - name: cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the cloud  
 requestBody:  
 description: The flavor to add or modify  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Flavor'  
 responses:  
 '200':  
 description: Flavor updated.  
 '400':  
 description: Error updateing flavor.  
 /flavor/{cloud}/{name}:  
 get:  
 tags:  
 - Flavor  
 summary: Returns the named flavor  
 description: Returns a flavor by name  
 operationId: cloudmesh.flavor.find\_by\_name  
 parameters:  
 - name: cloud  
 in: path  
 description: The name of the cloud  
 required: true  
 schema:  
 type: string  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the flavor  
 responses:  
 '200':  
 description: Retruning the information of the flavor  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Flavor'  
 '400':  
 description: No Flavor found.  
 '404':  
 description: The named flavor could not be found.  
 delete:  
 tags:  
 - Flavor  
 summary: Deletes the named flavor  
 description: Deletes a flavor by name  
 operationId: cloudmesh.flavor.delete\_by\_name  
 parameters:  
 - name: cloud  
 description: The name of the cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the flavor  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Flavor found.  
 '404':  
 description: The named flavor could not be found.  
components:  
 schemas:  
 Flavor:  
 type: object  
 description: The flavor  
 properties:  
 name:  
 type: string  
 description: Name of the flavor  
 id:  
 type: string  
 description: The id of the flavor for the named cloud  
 label:  
 type: string  
 description: A label that a user can set for this flavor  
 description:  
 type: string  
 description: A description for the flavor  
 ram:  
 type: integer  
 description: Number of bytes used for the image in RAM  
 swap:  
 type: integer  
 description: Number of bytes used for the image in SWAP  
 disk:  
 type: integer  
 description: Number of bytes used for the disk  
 ephemeral\_disk:  
 type: boolean  
 description: Specifies whether the flavor features an ephemeral disk  
 bandwidth:  
 type: integer  
 description: Bandwidth of the node  
 price:  
 type: float  
 description: Price for the flavor  
 cloud:  
 type: string  
 description: Name of the cloud this flavor is used in

### VM

VM is a service to manage virtual machines.

#### Schema Vm

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/vm.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| provider | string | Name of the provider |
| name | string | the unique name of the vm |
| image | string | the image name for the vm |
| flavor | string | the flavor name for the vm |
| region | string | an optional region |
| state | string | The state of the vm |
| private\_ips | string | The private IPs |
| public\_ips | string | The public IPS |
| metadata | string | The meta data passed along to the VM |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /vm/{cloud} | Returns a list of vms for the cloud |
| put | /vm/{cloud} | Add a vm |
| get | /vm/{cloud}/{name} | Returns the named vm |
| delete | /vm/{cloud}/{name} | Deletes the named vm |

##### /vm/{cloud}

###### GET /vm/{cloud}

Returns a list of all vms

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of vms |  |
| 400 | No Vm found. |  |
| 401 | Not authorized. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |

###### PUT /vm/{cloud}

Sets the named vm

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Vm updated. |  |
| 400 | Error updateing vm. |  |
| 401 | Not authorized. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |

##### /vm/{cloud}/{name}

###### GET /vm/{cloud}/{name}

Returns a vm by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the vm |  |
| 400 | No Vm found. |  |
| 401 | Not authorized. |  |
| 404 | The named vm could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |
| name | path | The name of the vm | True |  |

###### DELETE /vm/{cloud}/{name}

Deletes a vm by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Vm found. |  |
| 401 | Not authorized. |  |
| 404 | The named vm could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| cloud | path | The name of the cloud | True |  |
| name | path | ERROR: description missing | True |  |

#### vm.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Virtual Machine  
 description: |-  
  
 VM is a service to manage virtual machines.  
   
 termsOfService: https://github.com/cloudmesh-community/nist/blob/master/LICENSE.txt  
 contact:  
 name: NIST BDRA Interface Subgroup Service  
 url: https://cloudmesh-community.github.io/nist/spec/  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /vm/{cloud}:  
 get:  
 tags:  
 - Vm  
 summary: Returns a list of vms for the cloud  
 description: Returns a list of all vms  
 operationId: cloudmesh.vm.list  
 parameters:  
 - name: cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the cloud  
 responses:  
 '200':  
 description: The list of vms  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Vm'  
 '400':  
 description: No Vm found.  
 '401':  
 description: Not authorized.  
 put:  
 tags:  
 - Vm  
 summary: Add a vm  
 description: Sets the named vm  
 operationId: cloudmesh.vm.add  
 parameters:  
 - name: cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the cloud  
 requestBody:  
 description: The vm to add or modify  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Vm'  
 responses:  
 '200':  
 description: Vm updated.  
 '400':  
 description: Error updateing vm.  
 '401':  
 description: Not authorized.  
 /vm/{cloud}/{name}:  
 get:  
 tags:  
 - Vm  
 summary: Returns the named vm  
 description: Returns a vm by name  
 operationId: cloudmesh.vm.find\_by\_name  
 parameters:  
 - name: cloud  
 in: path  
 description: The name of the cloud  
 required: true  
 schema:  
 type: string  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the vm  
 responses:  
 '200':  
 description: Retruning the information of the vm  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Vm'  
 '400':  
 description: No Vm found.  
 '401':  
 description: Not authorized.  
 '404':  
 description: The named vm could not be found.  
 delete:  
 tags:  
 - Vm  
 summary: Deletes the named vm  
 description: Deletes a vm by name  
 operationId: cloudmesh.vm.delete\_by\_name  
 parameters:  
 - name: cloud  
 description: The name of the cloud  
 in: path  
 required: true  
 schema:  
 type: string  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the vm  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Vm found.  
 '401':  
 description: Not authorized.  
 '404':  
 description: The named vm could not be found.  
components:  
 schemas:  
 Vm:  
 type: object  
 properties:  
 provider:  
 type: string  
 description: Name of the provider  
 name:  
 type: string  
 description: the unique name of the vm  
 image:  
 type: string  
 description: the image name for the vm  
 flavor:  
 type: string  
 description: the flavor name for the vm  
 region:  
 type: string  
 description: an optional region  
 state:  
 type: string  
 description: The state of the vm  
 private\_ips:  
 type: string  
 description: The private IPs  
 public\_ips:  
 type: string  
 description: The public IPS  
 metadata:  
 type: string  
 description: The meta data passed along to the VM

### Secgroup

A security group defines the incoming and outgoing security rules which can then be assigned to a node when a node is being created. Once the node is up the connection to and from the node will be decided by the security group rules, in addition to any other possible rules applied on network devices or from the instance"s firewall settings. A security group may have one or multiple rules and a node may be associated with one or more security groups.

#### Schema Secgroup

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/secgroup.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| uuid | string | Unique identifier of the security group |
| name | string | name of the secgroup |
| description | string | describes what the secgroup is for |
| rules | array[SecGroupRule] | List of Secgroup rules |

#### Schema SecGroupRule

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/secgrouprule.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| uuid | string | Unique identifier of the rule |
| ingress | boolean | The defined security group rule is for ingress if True |
| egress | boolean | The defined security group rule is for egress if True |
| remote\_group | string | Name of the group if the rule is defined by group instead of IP range |
| protocol | string | The protocol used such as TCP, UDP, ICMP |
| from\_port | integer | Port range starting port |
| to\_port | integer | Port range ending port |
| cidr | string | The source or destination network in CIDR notation, e.g., 129.79.0.0/16 |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /secgroup | Returns all secgroups |
| get | /secgroup/{name} | Return the secgroup by name |
| post | /secgroup/{name} | Create a new named secgroup |
| post | /secgroup/{name}/rule | Create a new rule in the specified security group |
| get | /secgroup/{name}/rule/{rule} | Get an existing rule from the specified security group |
| delete | /secgroup/{name}/rule/{rule} | Delete an existing rule from the specified security group |

##### /secgroup

###### GET /secgroup

Returns all secgroups

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | secgroup info |  |
| 400 | Not found. |  |

##### /secgroup/{name}

###### GET /secgroup/{name}

Return the secgroup by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | secgroup info |  |
| 400 | Not found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | name of the security group | True |  |

###### POST /secgroup/{name}

Create a new named secgroup

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 201 | Created |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the secgroup to create | True |  |

##### /secgroup/{name}/rule

###### POST /secgroup/{name}/rule

Create a new rule in secgroup

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Created |  |
| 400 | Not found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the new secgroup to create | True |  |

##### /secgroup/{name}/rule/{rule}

###### GET /secgroup/{name}/rule/{rule}

Create a new rule in secgroup

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The security group rule definition info |  |
| 400 | Not found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The named of the secgroup from which the rule will be deleted | True |  |
| rule | path | The uuid of the rule to be deleted | True |  |

###### DELETE /secgroup/{name}/rule/{rule}

Create a new rule in secgroup

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deleted. |  |
| 400 | Not found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The named of the secgroup from which the rule will be deleted | True |  |
| rule | path | The uuid of the rule to be deleted | True |  |

#### secgroup.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Secgroup  
 description: |-  
   
 A security group defines the incoming and outgoing security rules  
 which can then be assigned to a node when a node is being created.  
 Once the node is up the connection to and from the node will be  
 decided by the security group rules, in addition to any other possible  
 rules applied on network devices or from the instance"s firewall  
 settings.  
 A security group may have one or multiple rules and a node may be  
 associated with one or more security groups.  
   
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /secgroup:  
 get:  
 tags:  
 - Secgroup  
 summary: Returns all secgroups  
 description: Returns all secgroups  
 operationId: cloudmesh.secgroup.get  
 responses:  
 '200':  
 description: secgroup info  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: "#/components/schemas/Secgroup"  
 '400':  
 description: Not found.  
 /secgroup/{name}:  
 get:  
 tags:  
 - Secgroup  
 summary: Return the secgroup by name  
 description: Return the secgroup by name  
 operationId: cloudmesh.secgroup.get\_by\_name  
 parameters:  
 - name: name  
 description: name of the security group  
 in: path  
 required: true  
 type: string  
 responses:  
 '200':  
 description: secgroup info  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/Secgroup"  
 '400':  
 description: Not found.  
 post:  
 tags:  
 - Secgroup  
 summary: Create a new named secgroup  
 description: Create a new named secgroup  
 operationId: cloudmesh.secgroup.add  
 parameters:  
 - in: path  
 name: name  
 required: true  
 description: The name of the secgroup to create  
 schema:  
 type: string  
 responses:  
 '201':  
 description: Created  
 /secgroup/{name}/rule:  
 post:  
 tags:  
 - Secgroup  
 summary: Create a new rule in the specified security group  
 description: Create a new rule in secgroup  
 operationId: cloudmesh.secgroup.add\_rule  
 parameters:  
 - in: path  
 name: name  
 required: true  
 description: The name of the new secgroup to create  
 type: string  
 requestBody:  
 description: The new secgroup rule to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/SecGroupRule'  
 responses:  
 '200':  
 description: Created  
 '400':  
 description: Not found.  
 "/secgroup/{name}/rule/{rule}":  
 get:  
 tags:  
 - Secgroup  
 summary: Get an existing rule from the specified security group  
 description: Create a new rule in secgroup  
 operationId: cloudmesh.secgroup.get\_rule  
 parameters:  
 - in: path  
 name: name  
 required: true  
 description: The named of the secgroup from which the rule will be deleted  
 type: string  
 - in: path  
 name: rule  
 required: true  
 description: The uuid of the rule to be deleted  
 type: string  
 responses:  
 '200':  
 description: The security group rule definition info  
 content:  
 application/json:  
 schema:  
 $ref: "#/components/schemas/SecGroupRule"  
 '400':  
 description: Not found.  
 delete:  
 tags:  
 - Secgroup  
 summary: Delete an existing rule from the specified security group  
 description: Create a new rule in secgroup  
 operationId: cloudmesh.secgroup.delete\_rule  
 parameters:  
 - in: path  
 name: name  
 required: true  
 description: The named of the secgroup from which the rule will be deleted  
 type: string  
 - in: path  
 name: rule  
 required: true  
 description: The uuid of the rule to be deleted  
 type: string  
 responses:  
 '200':  
 description: Deleted.  
 '400':  
 description: Not found.  
components:  
 schemas:  
 Secgroup:  
 type: object  
 description: the security group object  
 properties:  
 uuid:  
 type: string  
 description: Unique identifier of the security group  
 name:  
 type: string  
 description: name of the secgroup  
 description:  
 type: string  
 description: describes what the secgroup is for  
 rules:  
 type: array  
 description: List of Secgroup rules  
 items:  
 $ref: "#/components/schemas/SecGroupRule"  
 SecGroupRule:  
 type: object  
 description: security group rule  
 properties:  
 uuid:  
 type: string  
 description: Unique identifier of the rule  
 ingress:  
 type: boolean  
 description: The defined security group rule is for ingress if True  
 egress:  
 type: boolean  
 description: The defined security group rule is for egress if True  
 remote\_group:  
 type: string  
 description: Name of the group if the rule is defined by group instead of IP range  
 protocol:  
 type: string  
 description: The protocol used such as TCP, UDP, ICMP  
 from\_port:  
 type: integer  
 description: Port range starting port  
 to\_port:  
 type: integer  
 description: Port range ending port  
 cidr:  
 type: string  
 description: The source or destination network in CIDR notation, e.g., 129.79.0.0/16

### Nic

A service to store Network Interface Controller (NIC) information.

#### Schema Nic

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/nic.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the nic |
| kind | string | kind of the nic, such as wireless |
| mac | string | the mac address |
| ip | string | the IP address |
| mask | string | the network mask |
| broadcast | string | the broadcast address |
| gateway | string | the gateway address |
| mtu | integer | the MTU of the NIC |
| bandwidth | integer | the bandwidth in bps |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /nic | Returns a list of nics |
| put | /nic | Set a nic |
| get | /nic/{name} | Returns the named nic |
| delete | /nic/{name} | Deletes the named nic |

##### /nic

###### GET /nic

Returns a list of all nics

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of nics |  |
| 400 | No Nic found. |  |

###### PUT /nic

Sets the named nic

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Nic updated. |  |
| 400 | Error updateing nic. |  |

##### /nic/{name}

###### GET /nic/{name}

Returns a nic by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the nic |  |
| 400 | No Nic found. |  |
| 404 | The named nic could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the nic | True |  |

###### DELETE /nic/{name}

Deletes a nic by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Nic found. |  |
| 404 | The named nic could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the nic | True |  |

#### nic.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Nic  
 description: |-  
   
 A service to store Network Interface Controller (NIC) information.  
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /nic:  
 get:  
 tags:  
 - Nic  
 summary: Returns a list of nics  
 description: Returns a list of all nics  
 operationId: cloudmesh.nic.list  
 responses:  
 '200':  
 description: The list of nics  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Nic'  
 '400':  
 description: No Nic found.  
 put:  
 tags:  
 - Nic  
 summary: Set a nic  
 description: Sets the named nic  
 operationId: cloudmesh.nic.add  
 requestBody:  
 description: The new nic to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Nic'  
 responses:  
 '200':  
 description: Nic updated.  
 '400':  
 description: Error updateing nic.  
 /nic/{name}:  
 get:  
 tags:  
 - Nic  
 summary: Returns the named nic  
 description: Returns a nic by name  
 operationId: cloudmesh.nic.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the nic  
 responses:  
 '200':  
 description: Retruning the information of the nic  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Nic'  
 '400':  
 description: No Nic found.  
 '404':  
 description: The named nic could not be found.  
 delete:  
 tags:  
 - Nic  
 summary: Deletes the named nic  
 description: Deletes a nic by name  
 operationId: cloudmesh.nic.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the nic  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Nic found.  
 '404':  
 description: The named nic could not be found.  
components:  
 schemas:  
 Nic:  
 type: object  
 description: the nic  
 properties:  
 name:  
 type: string  
 description: name of the nic  
 kind:  
 type: string  
 description: kind of the nic, such as wireless  
 mac:  
 type: string  
 description: the mac address  
 ip:  
 type: string  
 description: the IP address  
 mask:  
 type: string  
 description: the network mask  
 broadcast:  
 type: string  
 description: the broadcast address  
 gateway:  
 type: string  
 description: the gateway address  
 mtu:  
 type: integer  
 description: the MTU of the NIC  
 bandwidth:  
 type: integer  
 description: the bandwidth in bps

## Compute Management - Containers

### Containers

Numerous different containers are likely to be created and handling them becomes more and more time consuming as their number increases. This service helps to solve that issue by storing containers and their corresponding information.

#### Schema Container

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/container.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the container |
| version | string | version of the container |
| label | string | label of the container |
| type | string | type of the container |
| definition | string | definition or manifest of the container |
| imgURI | string | URI of the container |
| tags | array[string] | tags of the container |
| timestamp |  | timestamps associated with the resource |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /container | Returns a list of containeres |
| put | /container | Set an container |
| get | /container/{name} | Returns the named container |
| delete | /container/{name} | Deletes the named container |

##### /container

###### GET /container

Returns a list of all containeres

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of containerses |  |
| 400 | No Container found. |  |

###### PUT /container

Sets the named container

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Container updated. |  |
| 400 | Error updateing container. |  |

##### /container/{name}

###### GET /container/{name}

Returns an container by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the container |  |
| 400 | No Container found. |  |
| 404 | The named container could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the container | True |  |

###### DELETE /container/{name}

Deletes an container by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Container found. |  |
| 404 | The named container could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the container | True |  |

#### containers.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Containers  
 description: |-  
  
 Numerous different containers are likely to be created and handling them   
 becomes more and more time consuming as their number increases. This service   
 helps to solve that issue by storing containers and their corresponding   
 information.   
  
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /container:  
 get:  
 tags:  
 - Container  
 summary: Returns a list of containeres  
 description: Returns a list of all containeres  
 operationId: cloudmesh.container.list  
 responses:  
 '200':  
 description: The list of containerses  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Container'  
 '400':  
 description: No Container found.  
 put:  
 tags:  
 - Container  
 summary: Set an container  
 description: Sets the named container  
 operationId: cloudmesh.container.add  
 requestBody:  
 description: The new container to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Container'  
 responses:  
 '200':  
 description: Container updated.  
 '400':  
 description: Error updateing container.  
 /container/{name}:  
 get:  
 tags:  
 - Container  
 summary: Returns the named container  
 description: Returns an container by name  
 operationId: cloudmesh.container.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the container  
 responses:  
 '200':  
 description: Retruning the information of the container  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Container'  
 '400':  
 description: No Container found.  
 '404':  
 description: The named container could not be found.  
 delete:  
 tags:  
 - Container  
 summary: Deletes the named container  
 description: Deletes an container by name  
 operationId: cloudmesh.container.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the container  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Container found.  
 '404':  
 description: The named container could not be found.  
components:  
 schemas:  
 Container:  
 type: object  
 description: A record representing a container  
 properties:  
 name:  
 type: string  
 description: name of the container  
 version:  
 type: string  
 description: version of the container  
 label:  
 type: string  
 description: label of the container  
 type:  
 type: string  
 description: type of the container  
 definition:  
 type: string  
 description: definition or manifest of the container  
 imgURI:  
 type: string  
 description: URI of the container  
 tags:  
 type: array  
 description: tags of the container  
 items:  
 type: string  
 timestamp:  
 description: timestamps associated with the resource  
 $ref: "timestamp.yaml#/components/schemas/Timestamp"

## Compute Management - Functions

### Microservice

As part of microservices, a function with parameters that can be invoked has been defined.

#### Schema Microservice

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/microservice.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the microservice |
| endpoint | string | the end point of the microservice |
| function | string | the function the microservice represents |
| timestamp |  | timestamps associated with the resource |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /microservice | Returns a list of microservicees |
| put | /microservice | Set an microservice |
| get | /microservice/{name} | Returns the named microservice |
| delete | /microservice/{name} | Deletes the named microservice |

##### /microservice

###### GET /microservice

Returns a list of all microservicees

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of microserviceses |  |
| 400 | No Microservice found. |  |

###### PUT /microservice

Sets the named microservice

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Microservice updated. |  |
| 400 | Error updateing microservice. |  |

##### /microservice/{name}

###### GET /microservice/{name}

Returns an microservice by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the microservice |  |
| 400 | No Microservice found. |  |
| 404 | The named microservice could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the microservice | True |  |

###### DELETE /microservice/{name}

Deletes an microservice by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Microservice found. |  |
| 404 | The named microservice could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the microservice | True |  |

#### microservice.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Microservice  
 description: |-  
   
 As part of microservices, a function with parameters that can be  
 invoked has been defined.  
  
 termsOfService: "https://github.com/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /microservice:  
 get:  
 tags:  
 - Microservice  
 summary: Returns a list of microservicees  
 description: Returns a list of all microservicees  
 operationId: cloudmesh.microservice.list  
 responses:  
 '200':  
 description: The list of microserviceses  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Microservice'  
 '400':  
 description: No Microservice found.  
 put:  
 tags:  
 - Microservice  
 summary: Set an microservice  
 description: Sets the named microservice  
 operationId: cloudmesh.microservice.add  
 requestBody:  
 description: The new microservice to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Microservice'  
 responses:  
 '200':  
 description: Microservice updated.  
 '400':  
 description: Error updateing microservice.  
 /microservice/{name}:  
 get:  
 tags:  
 - Microservice  
 summary: Returns the named microservice  
 description: Returns an microservice by name  
 operationId: cloudmesh.microservice.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the microservice  
 responses:  
 '200':  
 description: Retruning the information of the microservice  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Microservice'  
 '400':  
 description: No Microservice found.  
 '404':  
 description: The named microservice could not be found.  
 delete:  
 tags:  
 - Microservice  
 summary: Deletes the named microservice  
 description: Deletes an microservice by name  
 operationId: cloudmesh.microservice.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the microservice  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Microservice found.  
 '404':  
 description: The named microservice could not be found.  
components:  
 schemas:  
 Microservice:  
 type: object  
 description: the microservice  
 properties:  
 name:  
 type: string  
 description: name of the microservice  
 endpoint:  
 type: string  
 description: the end point of the microservice  
 function:  
 type: string  
 description: the function the microservice represents  
 timestamp:  
 description: timestamps associated with the resource  
 $ref: "timestamp.yaml#/components/schemas/Timestamp"

## Reservation

### Reservation

Some services may consume a considerable amount of resources, necessitating the reservation of resources.

#### Schema Reservation

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/reservation.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the reservation |
| service | string | the name of the service on which we reserve |
| description | string | the description of the reservation |
| start | string | the start time and date |
| end | string | the end time and date |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /reservation | Returns a list of reservations |
| put | /reservation | Uploads a reservation to the list of reservations |
| get | /reservation/{name} | Returns the named reservation |
| delete | /reservation/{name} | Deletes the named reservation |

##### /reservation

###### GET /reservation

Returns a list of all reservations

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of reservations |  |
| 400 | No Reservations found. |  |

###### PUT /reservation

Uploads a reservation to the list of reservations

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Reservation updated. |  |
| 400 | Error updateing Reservation. |  |

##### /reservation/{name}

###### GET /reservation/{name}

Returns an reservation by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the alias |  |
| 400 | No reservation found. |  |
| 404 | The named reservation could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the reservation | True |  |

###### DELETE /reservation/{name}

Deletes an reservation by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Reservation found. |  |
| 404 | The named reservation could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the reservation | True |  |

#### reservation.yaml

openapi: '3.0.2'  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Reservation  
 description: |-  
   
 Some services may consume a considerable amount of resources,  
 necessitating the reservation of resources.  
   
 termsOfService: 'https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt'  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /reservation:  
 get:  
 tags:  
 - Reservation  
 summary: Returns a list of reservations  
 description: Returns a list of all reservations  
 operationId: cloudmesh.reservation.list  
 responses:  
 '200':  
 description: The list of reservations  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Reservation'  
 '400':  
 description: No Reservations found.  
 put:  
 tags:  
 - Reservation  
 summary: Uploads a reservation to the list of reservations  
 description: Uploads a reservation to the list of reservations  
 operationId: cloudmesh.reservation.add  
 requestBody:  
 description: The reservation to be uploaded  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Reservation'  
 responses:  
 '200':  
 description: Reservation updated.  
 '400':  
 description: Error updateing Reservation.  
 /reservation/{name}:  
 get:  
 tags:  
 - Reservation  
 summary: Returns the named reservation  
 description: Returns an reservation by name  
 operationId: cloudmesh.reservation.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the reservation  
 responses:  
 '200':  
 description: Retruning the information of the alias  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Reservation'  
 '400':  
 description: No reservation found.  
 '404':  
 description: The named reservation could not be found.  
 delete:  
 tags:  
 - Reservation  
 summary: Deletes the named reservation  
 description: Deletes an reservation by name  
 operationId: cloudmesh.reservation.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the reservation  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Reservation found.  
 '404':  
 description: The named reservation could not be found.  
components:  
 schemas:  
 Reservation:  
 type: object  
 description: the reservation  
 properties:  
 name:  
 type: string  
 description: name of the reservation  
 service:  
 type: string  
 description: the name of the service on which we reserve  
 description:  
 type: string  
 description: the description of the reservation  
 start:  
 type: string  
 format: date  
 description: the start time and date  
 end:  
 type: string  
 format: date  
 description: the end time and date

## Data Streams

### Stream

The stream object describes a data flow, providing information about the rate and number of items exchanged while issuing requests to the stream. A stream may return data items in a specific format that is defined by the stream.

#### Schema Stream

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/stream.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the stream |
| format | string | format of the stream |
| rate | integer | the rate of messages |
| limit | integer | the limit of items send |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /stream | Returns a list of streams |
| put | /stream | Set an stream |
| get | /stream/{name} | Returns the named stream |
| delete | /stream/{name} | Deletes the named stream |

##### /stream

###### GET /stream

Returns a list of all streams

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of streamses |  |
| 400 | No Stream found. |  |

###### PUT /stream

Sets the named stream

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Stream updated. |  |
| 400 | Error updateing stream. |  |

##### /stream/{name}

###### GET /stream/{name}

Returns an stream by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the stream |  |
| 400 | No Stream found. |  |
| 404 | The named stream could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the stream | True |  |

###### DELETE /stream/{name}

Deletes an stream by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Stream found. |  |
| 404 | The named stream could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the stream | True |  |

#### stream.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Stream  
 description: |-  
   
 The stream object describes a data flow, providing information  
 about the rate and number of items exchanged while issuing requests  
 to the stream. A stream may return data items in a specific format  
 that is defined by the stream.  
  
   
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /stream:  
 get:  
 tags:  
 - Stream  
 summary: Returns a list of streams  
 description: Returns a list of all streams  
 operationId: cloudmesh.stream.list  
 responses:  
 '200':  
 description: The list of streamses  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Stream'  
 '400':  
 description: No Stream found.  
 put:  
 tags:  
 - Stream  
 summary: Set an stream  
 description: Sets the named stream  
 operationId: cloudmesh.stream.add  
 requestBody:  
 description: The new stream to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Stream'  
 responses:  
 '200':  
 description: Stream updated.  
 '400':  
 description: Error updateing stream.  
 /stream/{name}:  
 get:  
 tags:  
 - Stream  
 summary: Returns the named stream  
 description: Returns an stream by name  
 operationId: cloudmesh.stream.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the stream  
 responses:  
 '200':  
 description: Retruning the information of the stream  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Stream'  
 '400':  
 description: No Stream found.  
 '404':  
 description: The named stream could not be found.  
 delete:  
 tags:  
 - Stream  
 summary: Deletes the named stream  
 description: Deletes an stream by name  
 operationId: cloudmesh.stream.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the stream  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Stream found.  
 '404':  
 description: The named stream could not be found.  
components:  
 schemas:  
 Stream:  
 type: object  
 description: the stream  
 properties:  
 name:  
 type: string  
 description: name of the stream  
 format:  
 type: string  
 description: format of the stream  
 rate:  
 type: integer  
 description: the rate of messages  
 limit:  
 type: integer  
 description: the limit of items send

### Filter

Filters can operate on a variety of objects and reduce the information received based on a search criterion.

#### Schema Filter

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/filter.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| name | string | name of the filter |
| function | string | the function of the data exchanged in the stream |
| kind | string | the filter kind or type |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /filter | Returns a list of filteres |
| put | /filter | Set an filter |
| get | /filter/{name} | Returns the named filter |
| delete | /filter/{name} | Deletes the named filter |

##### /filter

###### GET /filter

Returns a list of all filteres

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of filterses |  |
| 400 | No Filter found. |  |

###### PUT /filter

Sets the named filter

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Filter updated. |  |
| 400 | Error updateing filter. |  |

##### /filter/{name}

###### GET /filter/{name}

Returns an filter by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the filter |  |
| 400 | No Filter found. |  |
| 404 | The named filter could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the filter | True |  |

###### DELETE /filter/{name}

Deletes an filter by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Filter found. |  |
| 404 | The named filter could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the filter | True |  |

#### filter.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Filter  
 description: |-  
   
 Filters can operate on a variety of objects and reduce the  
 information received based on a search criterion.  
   
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /filter:  
 get:  
 tags:  
 - Filter  
 summary: Returns a list of filteres  
 description: Returns a list of all filteres  
 operationId: cloudmesh.filter.list  
 responses:  
 '200':  
 description: The list of filterses  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Filter'  
 '400':  
 description: No Filter found.  
 put:  
 tags:  
 - Filter  
 summary: Set an filter  
 description: Sets the named filter  
 operationId: cloudmesh.filter.add  
 requestBody:  
 description: The new filter to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Filter'  
 responses:  
 '200':  
 description: Filter updated.  
 '400':  
 description: Error updateing filter.  
 /filter/{name}:  
 get:  
 tags:  
 - Filter  
 summary: Returns the named filter  
 description: Returns an filter by name  
 operationId: cloudmesh.filter.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the filter  
 responses:  
 '200':  
 description: Retruning the information of the filter  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Filter'  
 '400':  
 description: No Filter found.  
 '404':  
 description: The named filter could not be found.  
 delete:  
 tags:  
 - Filter  
 summary: Deletes the named filter  
 description: Deletes an filter by name  
 operationId: cloudmesh.filter.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the filter  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Filter found.  
 '404':  
 description: The named filter could not be found.  
components:  
 schemas:  
 Filter:  
 type: object  
 description: the filter  
 properties:  
 name:  
 type: string  
 description: name of the filter  
 function:  
 type: string  
 description: the function of the data exchanged in the stream  
 kind:  
 type: string  
 description: the filter kind or type

## Deployment

### Deployment

A service to store software steack deployments.

#### Schema Deployment

[Reference: ☁️](https://github.com/cloudmesh/cloudmesh-nist/blob/master/spec/deployment.yaml)

|  |  |  |
| --- | --- | --- |
| Property | Type | Description |
| kind | string | the kind of the deployment |
| specification | string | the specification of the deployment |

#### Paths

|  |  |  |
| --- | --- | --- |
| HTTP | Path | Summary |
| get | /deployment | Returns a list of deploymentes |
| put | /deployment | Set an deployment |
| get | /deployment/{name} | Returns the named deployment |
| delete | /deployment/{name} | Deletes the named deployment |

##### /deployment

###### GET /deployment

Returns a list of all deploymentes

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | The list of deploymentses |  |
| 400 | No Deployment found. |  |

###### PUT /deployment

Sets the named deployment

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deployment updated. |  |
| 400 | Error updateing deployment. |  |

##### /deployment/{name}

###### GET /deployment/{name}

Returns an deployment by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Retruning the information of the deployment |  |
| 400 | No Deployment found. |  |
| 404 | The named deployment could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the deployment | True |  |

###### DELETE /deployment/{name}

Deletes an deployment by name

Responses

|  |  |  |
| --- | --- | --- |
| Code | Description | Schema |
| 200 | Deletion successful. |  |
| 400 | No Deployment found. |  |
| 404 | The named deployment could not be found. |  |

Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Located in | Description | Required | Schema |
| name | path | The name of the deployment | True |  |

#### deployment.yaml

openapi: "3.0.2"  
info:  
 version: 3.2.0  
 x-date: 008-06-2019  
 x-status: TODO  
 title: Deployment  
 description: |-  
   
 A service to store software steack deployments.  
   
 termsOfService: "https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt"  
 contact:  
 name: NIST BDRA Interface Subgroup  
 url: https://cloudmesh-community.github.io/nist  
 license:  
 name: Apache 2.0  
 url: https://github.com/cloudmesh/cloudmesh-nist/blob/master/LICENSE.txt  
servers:  
 - url: /cloudmesh/v3  
paths:  
 /deployment:  
 get:  
 tags:  
 - Deployment  
 summary: Returns a list of deploymentes  
 description: Returns a list of all deploymentes  
 operationId: cloudmesh.deployment.list  
 responses:  
 '200':  
 description: The list of deploymentses  
 content:  
 application/json:  
 schema:  
 type: array  
 items:  
 $ref: '#/components/schemas/Deployment'  
 '400':  
 description: No Deployment found.  
 put:  
 tags:  
 - Deployment  
 summary: Set an deployment  
 description: Sets the named deployment  
 operationId: cloudmesh.deployment.add  
 requestBody:  
 description: The new deployment to create  
 required: true  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Deployment'  
 responses:  
 '200':  
 description: Deployment updated.  
 '400':  
 description: Error updateing deployment.  
 /deployment/{name}:  
 get:  
 tags:  
 - Deployment  
 summary: Returns the named deployment  
 description: Returns an deployment by name  
 operationId: cloudmesh.deployment.find\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the deployment  
 responses:  
 '200':  
 description: Retruning the information of the deployment  
 content:  
 application/json:  
 schema:  
 $ref: '#/components/schemas/Deployment'  
 '400':  
 description: No Deployment found.  
 '404':  
 description: The named deployment could not be found.  
 delete:  
 tags:  
 - Deployment  
 summary: Deletes the named deployment  
 description: Deletes an deployment by name  
 operationId: cloudmesh.deployment.delete\_by\_name  
 parameters:  
 - name: name  
 in: path  
 required: true  
 schema:  
 type: string  
 description: The name of the deployment  
 responses:  
 '200':  
 description: Deletion successful.  
 '400':  
 description: No Deployment found.  
 '404':  
 description: The named deployment could not be found.  
components:  
 schemas:  
 Deployment:  
 type: object  
 description: the deployment  
 properties:  
 kind:  
 type: string  
 description: the kind of the deployment  
 specification:  
 type: string  
 description: the specification of the deployment

# Status Codes and Error Responses

In case of an error or a successful response, the response header contains a HTTP code (see <https://tools.ietf.org/html/rfc7231>). The response body usually contains the following:

* The HTTP response code;
* An accompanying message for the HTTP response code; and
* A field or object where the error occurred.

Table 1: HTTP Response Codes

|  |  |
| --- | --- |
| HTTP Response | Description Code |
| 200 | *OK* success code, for GET or HEAD request. |
| 201 | *Created* success code, for POST request. |
| 204 | *No Content* success code, for DELETE request. |
| 300 | The value returned when an external ID exists in more than one record. |
| 304 | The request content has not changed since a specified date and time. |
| 400 | The request could not be understood. |
| 401 | The session ID or OAuth token used has expired or is invalid. |
| 403 | The request has been refused. |
| 404 | The requested resource could not be found. |
| 405 | The method specified in the Request-Line isn’t allowed for the resource specified in the URI. |
| 415 | The entity in the request is in a format that’s not supported by the specified method. |

# Acronyms and Terms

The following acronyms and terms are used in this volume.

ACID

Atomicity, Consistency, Isolation, Durability

API

Application Programming Interface

ASCII

American Standard Code for Information Interchange

BASE

Basically Available, Soft state, Eventual consistency

Container

See <http://csrc.nist.gov/publications/drafts/800-180/sp800-180_draft.pdf>

Cloud Computing

The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. See <http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf>.

DevOps

A clipped compound of software DEVelopment and information technology OPerationS

Deployment

The action of installing software on resources

HTTP

HyperText Transfer Protocol HTTPS HTTP Secure

Hybrid

Cloud See <http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf>.

IaaS

Infrastructure as a Service SaaS Software as a Service

ITL

Information Technology Laboratory

Microservice Architecture

Is an approach to build applications based on many smaller modular services. Each module supports a specific goal and uses a simple, well-defined interface to communicate with other sets of services.

NBD-PWG

NIST Big Data Public Working Group

NBDRA

NIST Big Data Reference Architecture

NBDRAI

NIST Big Data Reference Architecture Interface

NIST

National Institute of Standards and Technology

OS

Operating System

REST

REpresentational State Transfer

Replica

A duplicate of a file on another resource to avoid costly transfer costs in case of frequent access.

Serverless Computing

Serverless computing specifies the paradigm of function as a service (FaaS). It is a cloud computing code execution model in which a cloud provider manages the function deployment and utilization while clients can utilize them. The charge model is based on execution of the function rather than the cost to manage and host the VM or container.

Software Stack

A set of programs and services that are installed on a resource to support applications.

Virtual Filesysyem

An abstraction layer on top of a distributed physical file system to allow easy access to the files by the user or application.

Virtual Machine

A VM is a software computer that, like a physical computer, runs an operating system and applications. The VM is composed of a set of specification and configuration files and is backed by the physical resources of a host.

Virtual Cluster

A virtual cluster is a software cluster that integrate either VMs, containers, or physical resources into an agglomeration of compute resources. A virtual cluster allows users to authenticate and authorize to the virtual compute nodes to utilize them for calculations. Optional high-level services that can be deployed on a virtual cluster may simplify interaction with the virtual cluster or provide higher-level services.

Workflow

The sequence of processes or tasks

WWW

World Wide Web

# Bibliography

Department of Defense. 2010. “The Dodaf Architecture Framework Version 2.02.” Report 2.02. Department of Defense. <https://dodcio.defense.gov/library/dod-architecture-framework/>.

Internet2 Middleware Architecture Committee for Education. 2016. “EduPerson Object Class Specification.” 201602. 2016: Internet2. <http://software.internet2.edu/eduperson/internet2-mace-dir-eduperson-201602.html>.

Laszewski, Gregor von. 2019a. “Configuration File Example: Coudmesh4.yaml.” Github. <https://github.com/cloudmesh/cloudmesh-cloud/blob/master/cloudmesh/etc/cloudmesh4.yaml>.

———. 2019b. “NIST Bdra Vol 8. Github Issues.” Github. <https://github.com/cloudmesh/cloudmesh-nist/issues>.

———. 2019c. “NIST Bdra Vol 8. OpenAPI Specifications.” Github. <https://github.com/cloudmesh-community/nist/tree/master/spec>.

Laszewski, Gregor von, Wo Chang, Fugang Wang, Badi Abdhul Wahid, Geoffrey C. Fox, Pratik Thakkar, Alicia Mara Zuniga-Alvarado, and Robert C. Whetsel. 2015. “NIST Big Data Interoperability Framework: Volume 8, Reference Architecture Interfaces.” Special Publication (NIST SP). Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/_uploadfiles/NIST.SP.1500-9.pdf>.

Laszewski, Gregor von, Fugang Wang, Badi Abdul-Wahid, Hyungro Lee, Geoffrey C. Fox, and and Wo Chang. 2017. “Cloudmesh in Support of the Nist Big Data Architecture Framework.” Indiana University. <https://github.com/cyberaide/nist/blob/master/vonLaszewski-nist.pdf>.

NIST. 2015a. “21.0 Final Version Page of the Nbd-Pwg Website.” Web Page. <https://bigdatawg.nist.gov/V2_output_docs.php>.

———. 2015b. “V1.0 Final Version Page of the Nbd-Pwg Website.” Web Page. <https://bigdatawg.nist.gov/V1_output_docs.php>.

NIST. n.d. “Big Data Public Working Group (NBD-PWG).” <https://bigdatawg.nist.gov/>.

The White House Office of Science and Technology Policy. 2014. “Big Data is a Big Deal.” OSTP Blog. <http://www.whitehouse.gov/blog/2012/03/29/big-data-big-deal>.

W. L. Chang (Co-Chair), A. Roy (Subgroup Co-chair), M. Underwood (Subgroup Co-chair), and NIST Big Data Public Working Group. 2019. “NIST Big Data Interoperability Framework: Volume 4, Big Data Security and Privacy (NIST SP 1500-4 VERSION 3).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

W. L. Chang (Co-Chair), D. Boyd (Subgroup Co-chair), O. Levin (Version 1 Subgroup Co-Chair), and NIST Big Data Public Working Group. 2019. “NIST Big Data Interoperability Framework: Volume 6, Big Data Reference Architecture (NIST SP 1500-6 VERSION 3).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

W. L. Chang (Co-Chair), G. Fox (Subgroup Co-chair), and NIST Big Data Public Working Group. 2019. “NIST Big Data Interoperability Framework: Volume 3, Big Data Use Cases and General Requirements (NIST SP 1500-3 VERSION 3).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

W. L. Chang (Co-Chair), G. von Laszewski (Editor), and NIST Big Data Public Working Group. 2019. “NIST Big Data Interoperability Framework: Volume 8, Big Data Reference Architecture Interfaces (NIST SP 1500-9 VERSION 2).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

W. L. Chang (Co-Chair), N. Grady (Subgroup Co-chair), and NIST Big Data Public Working Group. 2019a. “NIST Big Data Interoperability Framework: Volume 1, Big Data Definitions (NIST SP 1500-1 VERSION 3).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

———. 2019b. “NIST Big Data Interoperability Framework: Volume 2, Big Data Taxonomies (NIST SP 1500-2 VERSION 3).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

W. L. Chang (Co-Chair), R. Reinsch (Subgroup Co-chair), C. Austin (Editor), and NIST Big Data Public Working Group. 2019. “NIST Big Data Interoperability Framework: Volume 9, Adoption and Modernization (NIST SP 1500-10 VERSION 2).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

W. L. Chang (Co-Chair), R. Reinsch (Subgroup Co-chair), D. Boyd (Version 1 Subgroup Co-chair), C. Buffington (Version 1 Subgroup Co-chair), and NIST Big Data Public Working Group. 2019. “NIST Big Data Interoperability Framework: Volume 7, Big Data Standards Roadmap (NIST SP 1500-7 VERSION 3).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.

W. L. Chang (Co-Chair), S. Mishra (Editor), and NIST Big Data Public Working Group. 2019. “NIST Big Data Interoperability Framework: Volume 5, Big Data Architectures White Paper Survey (NIST SP 1500-5 VERSION 1).” Gaithersburg, MD: National Institute of Standards; Technology (NIST). <https://bigdatawg.nist.gov/show_InputDoc.php>.