

SAGA API Extension: Service Discovery API

Status of This Document

This document provides information to the grid community, proposing a standard for an extension to the Simple API for Grid Applications (SAGA). As such it depends upon the SAGA Core API Specification [3]. This document is intended to be used as input to the definition of language specific bindings for this API extension, and as reference for implementors of these language bindings. Distribution of this document is unlimited.

Copyright Notice

Copyright © Open Grid Forum (2007-2009). All Rights Reserved.

Document Change History

The following changes have been made in version 1.1 of this document:

- All attribute names are now consistent with the style of the main SAGA specification.
- Attributes: “InformationServiceUrl”, “ImplementationVersion” and “InterfaceVersion” have been added.
- A multi-valued attribute: “Capabilities” has been added. Consequently the description of the “Type” attribute has been simplified.

Abstract

This document specifies a Service Discovery API extension to the Simple API for Grid Applications (SAGA), a high level, application-oriented API for grid application development. This Service Discovery API is motivated by a number of Use Cases collected by the OGF SAGA Research Group in GFD.70 [4], and by requirements derived from these Use Cases, as specified in GFD.71 [5]). It allows users to find services with minimal prior knowledge of the grid or grids they plan to use.

Contents

| | | |
|----------|---|-----------|
| 1 | Introduction | 3 |
| 1.1 | Notational Conventions | 3 |
| 1.2 | Security Considerations | 3 |
| 2 | SAGA Service Discovery API | 4 |
| 2.1 | Introduction | 4 |
| 2.2 | Specification | 6 |
| 2.3 | Specification Details | 9 |
| 2.4 | Examples | 17 |
| 3 | Intellectual Property Issues | 19 |
| 3.1 | Contributors | 19 |
| 3.2 | Intellectual Property Statement | 19 |
| 3.3 | Disclaimer | 20 |
| 3.4 | Full Copyright Notice | 20 |
| | References | 21 |

1 Introduction

Most of the SAGA use cases [4] exhibit a need for service discovery (SD) - though it is sometimes described in other terms, such as searching for resources, or even searching for components. It would appear that the real need is to discover services. The fact that these services may make use of certain resources or components is not the prime interest of the the end user – ultimately access will be via the interface offered by the service.

This API extension is tailored to provide exactly this functionality, at the same time keeping coherence with the SAGA Core API look & feel, and keeping other Grid related boundary conditions (in particular middleware abstraction and authentication/authorization) in mind.

1.1 Notational Conventions

In structure, notation and conventions, this documents follows those of the SAGA Core API specification [3], unless noted otherwise.

1.2 Security Considerations

As the SAGA API is to be implemented on different types of Grid (and non-Grid) middleware, it does not specify a single security model, but rather provides hooks to interface to various security models – see the documentation of the `saga::context` class in the SAGA Core API specification [3] for details.

A SAGA implementation is considered secure if and only if it fully supports (i.e. implements) the security models of the middleware layers it builds upon, and neither provides any (intentional or unintentional) means to by-pass these security models, nor weakens these security models' policies in any way.

2 SAGA Service Discovery API

2.1 Introduction

The SAGA Service Discovery API provides a mechanism to locate services.

The main SAGA APIs assume that certain URLs are known and will be passed in to the API calls. For example, the constructor for the `saga::job::job_service` class takes the URL of a resource manager. The specification of the `job_service` class allows the implementation to find the resource manager if no URL is provided. A user could therefore delegate to the `job_service` the task of choosing a suitable resource manager or, if more control on the choice of resource manager is required, the user could use the service discovery API directly and pass in the URL of the resource manager. It is likely that an implementation of the `job_service` would itself use the service discovery API to locate a resource manager when none has been specified. Another example where the user needs to locate a service is to make a `saga::rpc::rpc` call.

It is expected that this SD API will make use of various information systems or other service discovery mechanisms. The quality of the information returned will depend upon the quality of the data in the back-end system or systems.

2.1.1 Service Model

The API is based upon the GLUE (version 1.3) model of a service [1] as summarized in figure 1. This service model is also compatible with GLUE 2.0 [2].

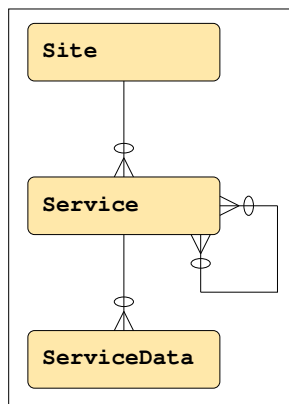


Figure 1: ER diagram of Service Model

The figure indicates that a *Site* may host many *Services* and a *Service* has multiple *ServiceData* entries associated with it. Each *ServiceData* entry is represented by a key and a value, thus allowing any set of keyword/value pairs to be associated with an instance of a *Service*. In addition, a *Service* has a many-to-many relationship with itself. This allows the model to describe groupings of services.

It is possible that the Service Discovery API may be incompatible with a future version of GLUE. This issue will be addressed, if necessary, in a future revision of this document.

2.1.2 Classes

The SAGA Service Discovery API consists of a `discoverer` class with a single method: `list_services`. This method returns a list of objects of the `service_description` class, filtered according to several specified filters.

The `service_description` class has three methods. One of these, `get_url`, is all that most people will use to obtain the address registered for the service. In the case of a Web Service, this will be the service endpoint. It also implements the `saga::attributes` interface, and thus exposes additional *ReadOnly* properties of the service, such as its type and uid. These might be used by those who wish to generate a web page of services, or need detailed information for other purposes. There is a method `get_related_services` that returns the set of related `service_descriptions`, which represent related services. Finally, there is a method `get_data` to access the set of further key value pairs. This method returns a `service_data` object, which also implements the `saga::attributes` interface giving *ReadOnly* access to all the key names and values in the `service_data` object.

By making the `service_description` implement the `saga::attributes` interface, and by referencing a separate `service_data` object holding the key value pairs, potential key name clashes between the sets of pre-defined and free-form attributes are avoided.

2.2 Specification

```
package saga.sd {

class discoverer : implements saga::object
{
    CONSTRUCTOR    (in session    session,
                   in url        url = "",
                   out discoverer dis);
    DESTRUCTOR     (in discoverer dis);

    list_services (in string    service_filter,
                  in string    data_filter,
                  in string    authz_filter,
                  out array<service_description> services);

    list_services (in string    service_filter,
                  in string    data_filter,
                  out array<service_description> services);
}

class service_description : implements saga::object
                          implements saga::attributes
{
    // no CONSTRUCTOR
    DESTRUCTOR (in service_description sdesc);

    get_url          (out string    url);
    get_related_services (out array<service_description>
                          services);
    get_data         (out service_data data);

    // Attributes:
    //
    // name:  Url
    // desc:  url to contact the service
    // mode:  ReadOnly
    // type:  String
    // notes: The get_url call obtains the same information.
    //
    // name:  Capabilities
    // desc:  identifiable aspects of functionality
    // mode:  ReadOnly
    // type:  Vector String
}
```

```
// notes: Capability values to locate SAGA accessible
// services are listed below. For other services
// an appendix of the GLUE 2 specification[2]
// lists some possible values. A capability MUST
// NOT be an empty string.
//
// name: Type
// desc: type of service
// mode: ReadOnly
// type: String
// notes: The specification imposes no rules on the
// values of this field except that it MUST
// NOT be an empty string.
//
// name: Uid
// desc: unique identifier of service
// mode: ReadOnly
// type: String
// notes: The specification imposes no rules on the
// values of this field except that it MUST
// NOT be an empty string.
//
// name: Site
// desc: name of site
// mode: ReadOnly
// type: String
// notes: The specification imposes no rules on the
// values of this field except that it MUST
// NOT be an empty string.
//
// name: Name
// desc: name of service - not necessarily unique
// mode: ReadOnly
// type: String
// notes: The specification imposes no rules on the
// values of this field except that it MUST
// NOT be an empty string.
//
// name: Implementor
// desc: name of the organisation providing the
// implementation of the service.
// mode: ReadOnly
// type: String
// notes: The specification imposes no rules on the
// values of this field except that it MUST
// NOT be an empty string.
```

```
//
// name: ImplementationVersion
// desc: the version of the service implementation
// mode: ReadOnly
// type: String
// notes: The specification imposes no rules on the
//        values of this field except that it MUST
//        NOT be an empty string.
//
// name: InterfaceVersion
// desc: the version of the service interface.
// mode: ReadOnly
// type: String
// notes: The specification imposes no rules on the
//        values of this field except that it MUST
//        NOT be an empty string.
//
// name: RelatedServices
// desc: uids of related services
// mode: ReadOnly
// type: Vector String
// notes: This holds the uids of the related services.
//        This is unlike the call get_related_services
//        which returns an array of service_descriptions.
//
// name: InformationServiceUrl
// desc: url of the information service used to
//        obtain this service_description
// mode: ReadOnly
// type: String
// notes: This must have a valid URL syntax
}

class service_data : implements saga::object
                    implements saga::attributes
{
    // no CONSTRUCTOR
    DESTRUCTOR (in service_data sd);

    // Attributes (extensible):
    //
    // no attributes pre-defined
}

}
```


2.3 Specification Details

The API will typically use some underlying information system and should not contact the services to check their availability. The user must expect that a service provided by the Service Discovery API may not be available. Even if the API were to contact a service to confirm its availability, by the time the user attempts to use that service, it may have failed. Similarly the API cannot be guaranteed to provide a complete set of matching services - it is the responsibility of the implementation to apply any algorithm it chooses to return a set of services.

The API may try to use an underlying information system but not be able to access it. The precise behaviour is implementation dependent - for example if it uses adapters it may try a different one. If no result can be returned because of information system or other internal problems, it **SHOULD** throw the `NoSuccess` exception. Note that an implementation **MAY** choose to return search results from multiple backend services. In the case of an adaptor based implementation, several adaptors may get queried at once, and the results may be collated into a single list, if the specified URL does not limit the range of usable adaptors.

`class discoverer`

The `discoverer` object is the entry point for service discovery. Apart from the constructor and destructor it has one operation: `list_services` which returns the list of descriptions of services matching the specified filter strings.

An implementation **SHOULD** return the results in a random order if there is more than one result to avoid any tendency to overload particular services while leaving others idle.

There are three filter strings: `service_filter`, `data_filter` and `authz_filter` which act together to restrict the set of services returned. Each of the filter strings uses SQL92 syntax as if it were part of a **WHERE** clause acting to select from a single table that includes columns as described below for that filter type. SQL92 has been chosen because it is widely known and has the desired expressive power. Multi-valued attributes are treated as a set of values.

Three strings are used, rather than one, as this clarifies the description of the functionality, avoids problems with key values being themselves existing GLUE attributes, and facilitates implementation as it makes it impossible to specify

constraints that correlate, for example, service and authz information. Only the following operators are permitted in expressions not involving multi-valued attributes: IN, LIKE, AND, OR, NOT, =, >=, >, <=, <, <> in addition to column names, parentheses, column values as single quoted strings, numeric values and the comma. For a multi-valued attribute, the name of the attribute MUST have the keyword ALL or ANY immediately before it, unless comparison with a set literal is intended. For each part of the expression, the attribute name MUST precede the literal value. An implementation SHOULD try to give an informative error message if the filter string does not conform. It is, however, sufficient to report in which filter string the syntax error was found.

The LIKE operator matches string patterns:

'%xyz' matches all entries with trailing xyz

'xyz%' matches all entries with leading xyz

'%xyz%' matches all entries with xyz being a substring

The ESCAPE keyword can be used with LIKE in the normal way.

Column names are not case sensitive but values are.

No use-case has been identified for the operators >=, >, <=, < to be applied to strings. An Implementation wishing to support these comparison operators on strings MUST select a collation sequence. Alternatively, an implementation CAN treat all string comparisons as true, or reject them as invalid SQL.

Service Filter

Column names in the `service_filter` are:

Capabilities identifiable aspects of functionality.

This API does not restrict values of the service capability – they might be DNS names, URNs or any other non-empty strings. However, capability values to locate SAGA services usable for SAGA operations SHOULD use capabilities constructed with the form:

```
org.ogf.saga.service.<service_name>
```

where <service_name> is the name of the SAGA service. Service names for the core services defined in GFD.90 are defined in table 1 below. For each <service_name>, the package and class implementing that service is shown. Other SAGA packages are responsible for defining their own service names within their specifications.

| Name | Package | Class |
|-------------------|-------------------|-------------------|
| job | saga.job | job_service |
| directory | saga.file | directory |
| logical-directory | saga.logical_file | logical_directory |
| stream | saga.stream | stream_service |
| rpc | saga.rpc | rpc |

Table 1: SAGA service names to be used as capabilities.

An implementation might map a capability onto a number of different underlying service types.

To locate other services those capabilities listed in an appendix of the GLUE 2.0 specification [2] might be used.

Typically a service will only have one SAGA capability but it may have many GLUE capabilities.

Type type of service. This API does not restrict values of the service type – it might be a DNS name, a URN or any other non-empty string.

Uid unique identifier of service

Site name of site the service is running at

Name name of service (not necessarily unique)

Implementor name of the organisation providing the implementation of the service

ImplementationVersion the version of the service implementation

InterfaceVersion the version of the service interface

RelatedServices the uids of services related to the one being looked for

Url the endpoint to contact the service - will normally be used (if at all) with the LIKE operator

Some examples are:

- ANY Capabilities = 'org.ogf.saga.service.job'
- Site IN ('INFN-CNAF', 'RAL-LCG2')
- Type = 'org.glite.ResourceBroker' \
 AND Site LIKE '%.uk' \
 AND Implementor = 'EGEE'

- ANY RelatedServices = 'someServiceUID'

Note the use of the ANY keyword in two of these examples as **Capabilities** and **RelatedServices** are multi-valued.

Data Filter

Column names in the **data_filter** string are matched against the service data key/value pairs. No keys are predefined by this specification.

If values are specified as numeric values and not in single quotes, the service data will be converted from string to numeric for comparison.

Data attributes may be multi-valued. If a **data_filter** string does not have the correct syntax to accept multi-valued attributes, and a service has more than one value for an attribute mentioned in the filter, that service MUST be rejected.

Some examples are:

- source = 'RAL-LCG2' OR destination = 'RAL-LCG2'
- RunningJobs >= 1 AND RunningJobs <= 5

Authz Filter

The set of column names in the **authz_filter** is not defined. Instead the list below shows a possible set of names and how they might be interpreted. Each of these column names could reasonably be related to an authorization decision. Implementations MAY reuse the attribute names defined for the **saga::context** class.

Vo virtual organization - will often be used with the IN operator

Dn an X.509 “distinguished name”

Group a grouping of people within a Virtual Organization

Role values might include “Administrator” or “ProductionManager”

It is expected that many of the attributes used in the **authz_filter** will be multi-valued.

Some examples, where VO is assumed to be multi-valued are:

- ANY Vo IN ('cms', 'atlas')
- Vo = ('dteam')

Note the use of the set constructor in both examples. Being a set, ('aaa', 'bbbb') is of course the same as ('bbb', 'aaa').

The `list_services` operation is overloaded: the last parameter the `authz_filter` may be omitted. If it is omitted the authorization filtering is performed on the contexts in the session. This is quite different from including the `authz_filter` parameter with an empty string which means that there is no authz filtering.

- CONSTRUCTOR

Purpose: create a new discoverer object

Format: CONSTRUCTOR (in session session,
in url url = "",
out discoverer dis);

Inputs: session: session handle

url: URL to guide the implementation

Outputs: dis: new discoverer object

Throws: NotImplemented
IncorrectURL
DoesNotExist
AuthorizationFailed
AuthenticationFailed
Timeout
NoSuccess

Notes:

- the url specified as in input parameter is to assist the implementation to locate the underlying information system such that it can be queried.
- if the url is syntactically valid, but no service can be contacted at that URL, a 'DoesNotExist' exception is thrown.
- the semantics for the other exceptions is as outlined in the SAGA Core API specification.
- note that the session parameter is optional, as described in the SAGA Core API specification, section 3.5.2. Also Section 2.2.2 of the same document applies to url and its default value.

- DESTRUCTOR

Purpose: destructor for discoverer object
Format: DESTRUCTOR (in discoverer dis)
Inputs: dis: object to be destroyed
Outputs: -
Throws: -
Notes: -

- list_services

Purpose: return the set of services that pass the set of specified filters
Format: list_services (in string service_filter,
in string data_filter,
in string authz_filter,
out array<service_description>
services);
Inputs: service_filter: filter on the basic service and site attributes and on related services
data_filter: filter on key/value pairs associated with the service
authz_filter: filter on authorization information associated with the service
Outputs: services: list of service descriptions matching the filter criteria
Throws: BadParameter
AuthorizationFailed
AuthenticationFailed
Timeout
NoSuccess
Notes: - the last parameter, the authz_filter, may be omitted. In this case an implicit authz_filter is constructed from the contexts of the session. Note that this is different from an empty authz_filter, as that would apply no authorization filter at all.
- if any filter has an invalid syntax, a 'BadParameter' exception is thrown.
- if any filter uses invalid keys, a 'BadParameter' exception is thrown. However the data_filter never signals invalid keys as there is no schema with permissible key names.
- the semantics for the other exceptions is as outlined in the SAGA Core API specification.

`class service_description`

The `service_description` class implements the `saga::attributes` interface and offers getter methods to obtain details of that service. The attributes are based on those found in GLUE. In addition to the `saga::attributes` interface, it has the methods listed below. This class has no CONSTRUCTOR as objects of this type are created only by other objects in the service discovery API.

- DESTRUCTOR
 - Purpose: Destructor for `service_data` object.
 - Format: DESTRUCTOR (in `service_description sdesc`)
 - Inputs: `sdesc` object to be destroyed
 - Outputs: -
 - Throws: -
 - Notes: -

 - `get_url`
 - Purpose: return the URL to contact the service
 - Format: `get_url` (out string url);
 - Inputs: -
 - Outputs: `url:` URL to contact the service
 - Throws: -
 - Notes: - the URL may also be obtained using the `saga::attributes` interface.

 - `get_related_services`
 - Purpose: return the set of related services
 - Format: `get_related_services` (out array<`service_description`> services);
 - Inputs: -
 - Outputs: `services:` set of related `service_description` objects
 - Throws: `AuthorizationFailed`
`AuthenticationFailed`
`Timeout`
`NoSuccess`
 - Notes: - this function returns an array of `service_descriptions`. Alternatively, the `saga::attributes` interface may be used to get the uids of the related services.
-

- the returned list can be empty.
 - if the underlying information system is unable to find one or more of the related services an exception MUST NOT be thrown.
- `get_data`
- Purpose:** return a `service_data` object with the `ServiceData` key/value pairs
 - Format:** `get_data` (out `service_data` data);
 - Inputs:** -
 - Outputs:** `data:` a `service_data` object
 - Throws:** -
 - Notes:** - the returned `service_data` object may be empty, i.e. has no attributes at all.
-

`class service_data`

The `service_data` class implements the `saga::attributes` interface and offers getter methods for the user to read key/value pairs defined by the service publisher. Service publishers are completely free to define their own key names. Access to the keys and values is through the `saga::attributes` interface. The class provides no other methods. This class has no `CONSTRUCTOR`, as it can only be created by calling `get_data` on a `service_description` instance.

- `DESTRUCTOR`
 - Purpose:** destructor for `service_data` object
 - Format:** `DESTRUCTOR` (in `service_data` sd)
 - Inputs:** `sd` object to be destroyed
 - Outputs:** -
 - Throws:** -
 - Notes:** -
-

2.4 Examples

This C++ example shows, using a possible C++ binding, how the SAGA service discovery model can be used to retrieve services from the underlying information system. All the SAGA job services (org.ogf.saga.service.job) with a name of “CERN-PROD-rb” and accessible by a context of the current session and for which the “RunningJobs” parameter is greater than 10 are requested. The service objects returned from the `list_services` call are then queried for attributes and key/values using its getter methods.

Note that this example is a little artificial as it would be more sensible to issue a sufficiently precise query so that any service returned would be suitable and then call `get_url` on the first service returned.

Code Example

```
1  #include <iostream>
2  #include <vector>
3  #include <string>
4  #include <saga.hpp>
5
6  using namespace std;
7
8  main () {
9      saga::sd::discoverer d (SAGA_DEFAULT_SESSION);
10     vector<string> attrib_names;
11     vector<string> attrib_values;
12
13     string svc_filter = "ANY Capabilities = 'org.ogf.saga.service.job'
14                        AND Name = 'CERN-PROD-rb'";
15     string data_filter = "RunningJobs > 10";
16
17     vector <saga::sd::service_description> slist =
18         d.list_services (svc_filter, data_filter);
19
20     cout << "Total number of services found = "
21          << slist.size() << endl;
22
23     for (unsigned int i = 0; i < slist.size (); i++) {
24         cout << "SERVICE #" << i << endl;
25         attrib_names = slist[i].list_attributes();
26         for (unsigned int j = 0; j < attrib_names.size (); j++) {
27             cout << "    " << attrib_names[j]
28                  << " = " << slist[i].get_attribute (attrib_names[j])
29                  << endl;
30         }
31     }
32 }
```

This C example is similar to the C++ one above but this time includes the authz filter parameter. This is just an extract from a possible C binding.

Code Example

```
1  SAGA_SD_Discoverer *sd =
2      SAGA_SD_create_discoverer (SAGA_DEFAULT_SESSION);
3
4  if ( sd == NULL ) {
5      fprintf (stderr, "Could not create SAGA SD object: %s",
6              SAGA_Session_get_error (SAGA_DEFAULT_SESSION));
7      return -1;
8  }
9
10 char service_filter[] = "ANY Capabilities = 'org.ogf.saga.service.job'
11                        AND Name = 'CERN-PROD-rb'";
12 char authz_filter[]   = "Vo IN ('atlas', 'dteam')";
13 char data_filter[]    = "RunningJobs > 10";
14
15 SAGA_SD_ServiceDescription *slist = SAGA_SD_list_services(
16     sd, service_filter, data_filter, authz_filter);
17
18 printf ("Total number of services found : %d\n", slist->size);
19
20 for (int i = 0; i < slist->size; i++) {
21     printf("SERVICE #%d\n", i);
22
23     SAGA_SD_Attribute *keys = SAGA_SD_list_attributes(slist[i]);
24
25     for (int j = 0; j < keys->size; j++) {
26         printf ("    %s = %s\n", key->names[j],
27             SAGA_SD_get_attribute (slist[i], key->names[j]));
28     }
29
30     SAGA_SD_free_attributes (keys);
31 }
32
33 SAGA_SD_free_services (slist);
```

3 Intellectual Property Issues

3.1 Contributors

This document is the result of the joint efforts of several contributors. The authors listed here and on the title page are those committed to taking permanent stewardship for this document. They can be contacted in the future for inquiries about this document.

Steve Fisher

dr.s.m.fisher@gmail.com
Rutherford Appleton Lab
Chilton
Didcot
Oxon
OX11 0QX
UK

Antony Wilson

antony.wilson@stfc.ac.uk
Rutherford Appleton Lab
Chilton
Didcot
Oxon
OX11 0QX
UK

Arumugam Paventhan

a.paventhan@gmail.com
Rutherford Appleton Lab
Chilton
Didcot
Oxon
OX11 0QX
UK

We wish to thank Pascal Kleijer (NEC Corporation) and Andre Merzky (Louisiana State University) for making written comments on earlier drafts and encouraging us to be true to the SAGA style.

3.2 Intellectual Property Statement

The OGF takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; neither does it represent that it has made any effort to identify any such rights. Copies of claims of rights made available for publication and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the OGF Secretariat.

The OGF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights which may cover technology that may be required to practice this recommendation. Please address the information to the OGF Executive Director.

3.3 Disclaimer

This document and the information contained herein is provided on an "As Is" basis and the OGF disclaims all warranties, express or implied, including but not limited to any warranty that the use of the information herein will not infringe any rights or any implied warranties of merchantability or fitness for a particular purpose.

3.4 Full Copyright Notice

Copyright (C) Open Grid Forum (2007-2009). All Rights Reserved.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to the OGF or other organizations, except as needed for the purpose of developing Grid Recommendations in which case the procedures for copyrights defined in the OGF Document process must be followed, or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by the OGF or its successors or assignees.

References

- [1] S. Andreatto et al. GLUE Schema Specification version 1.3. <https://forge.gridforum.org/sf/go/doc14185?nav=1>, 2007.
- [2] S. Andreatto et al. GLUE Schema Specification version 2.0. <http://www.ogf.org/documents/GFD.147.pdf>, 2009.
- [3] T. Goodale, S. Jha, H. Kaiser, T. Kielmann, P. Kleijer, A. Merzky, J. Shalf, and C. Smith. A Simple API for Grid Applications (SAGA). Grid Forum Document GFD.90, 2008. Open Grid Forum.
- [4] A. Merzky and S. Jha. A Collection of Use Cases for a Simple API for Grid Applications. Grid Forum Document GFD.70, 2006. Global Grid Forum.
- [5] A. Merzky and S. Jha. A Requirements Analysis for a Simple API for Grid Applications. Grid Forum Document GFD.71, 2006. Global Grid Forum.