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Grid Data Service Specification

Status of This Memo

This memo provides information to the Grid community regarding the specification of Grid Database Services. The specification is presently a draft for discussion. It does not define any standards or technical recommendations. Distribution is unlimited.

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Abstract

Data management systems are central to many applications across multiple domains, and play a significant role in many others. Web services provide implementation neutral facilities for describing, invoking and orchestrating collections of networked resources. The Open Grid Services Architecture (OGSA) provides consistent interfaces for creating, managing and exchanging information among Grid services, which are dynamic computational artefacts cast as Web services. Both Web and Grid service communities stand to benefit from the provision of consistent, agreed service interfaces to data management systems. Such interfaces must support the description and use of data management systems using Web service standards, taking account of the design conventions and mandatory features of Grid services. This document presents a specification for a collection of generic data access interfaces that can be extended to support access to specific kinds of data resource, such as relational databases, XML repositories or files.

The proposal is presented for discussion within the Global Grid Forum (GGF) Database Access and Integration Services (DAIS) Working Group, with a view to the document evolving to become a proposed recommendation. There are several respects in which the current proposal is incomplete, but it is hoped that the material included is sufficient to allow an informed discussion to take place concerning both its form and substance. Future versions of this document will be revised to remove the dependency on the Open Grid Services Infrastructure (OGSI).



Contents

Abstract	1
1. Introduction	2
2. Notational Conventions	3
3. Specification Overview	4
3.1 Scope of Specification	4
3.2 Port Type Summary	4
3.3 Port Type Composition	4
3.4 Data Services Derivations	5
4. Interface Design Principles	5
4.1 Data Service Artifact Relationships	6
4.2 Data Service Creation	6
4.3 Query Expression Types	7
4.4 Access Control	7
4.5 Operation Validity	7
4.6 Data Formats	7
4.7 Sessions	8
4.8 Data Service Management	8
5. Related Standards	8
5.1 WS-Agreement	8
5.2 Metadata	8
5.3 Notification	9
5.4 Transactions	9
5.5 Security	10
5.6 Information Dissemination	10
5.7 GGF Data Area: OREP-WG	10
5.8 GGF Data Area: GridFTP	10
5.9 OASIS: WSDDM	10
5.10 GGF Information Systems and Performance Area: CMM-WG	10
5.11 GGF Information Systems and Performance Area: CGS-WG	10
6. DataDescription portType	10
6.1 Service Data Declarations	10
6.2 Operations	11
7. DataAccess portType	11
7.1 Service Data Declarations	11
7.2 Operations	11
8. DataFactory portType	11
8.1 Inherited Service Data Declarations	11
8.2 Operations	12
9. DataManagement portType	12
9.1 Service Data Declarations	12
9.2 Operations	12
10. Security Considerations	12
11. Conclusions	12
Editor Information	13
Contributors	13
Acknowledgements	14
Intellectual Property Statement	14
Full Copyright Notice	14
References	14

1. Introduction

Data access plays an important role in many Grid applications. In general, data access involves both retrieval and manipulation of data, which may be stored using a range of paradigms. This

implies the need for a flexible framework for request evaluation, and close integration with functionality for managing and moving data retrieved from, or for insertion into, a data resource.

This document provides a specification for a collection of generic grid data access interfaces. These interfaces instantiate the framework provided by the *OGSA Data Services* proposal [Data Services], in that interfaces are categorized according to the support they provide for data description, data access, data service creation and data management. As such, this document should be read in conjunction with the *OGSA Data Services* proposal. The specification does not mandate how these interfaces are composed into services; the proposed interfaces may be used in isolation or in conjunction with others. Furthermore, as this document stops short of providing interfaces for specific categories of data service, such as relational or XML data services, a more complete picture is provided by reading this document in conjunction with proposals for access to relational [GDRR] and XML [GDXR] representations of data. All of these documents assume some familiarity with the Open Grid Services Infrastructure (OGSI) [OGSI].

2. Notational Conventions

The key words "MUST," "MUST NOT," "REQUIRED," "SHALL," "SHALL NOT," "SHOULD," "SHOULD NOT," "RECOMMENDED," "MAY," and "OPTIONAL" are to be interpreted as described in RFC-2119 [RFC2119].

This specification generally adopts the terminology defined in the *OGSA Data Services* document [Data Services]. The *OGSA Data Services* document is still evolving and this terminology is likely to change in future versions of the DAIS Working Group specifications.

Term	Description
Data Service	An OGSI compliant web service that implements at least one of the four portTypes, defined in this specification, either directly or indirectly.
Data Resource	The components with which a Data Service's implementation interacts to implement the functionality of the service.
Data Set	An encoding of data in a syntax suitable for externalization outside of a Data Service.

This specification uses namespace prefixes throughout; these are listed in the table below. Note that the choice of any namespace prefix is arbitrary and not semantically significant.

Prefix	Namespace
dais	http://www.ggf.org/namespaces/2004/03/DAIS
gsa	WS-Agreement namespace URI
gwsdl	http://www.ggf.org/namespaces/2003/03/gridWSDLExtensions
http	http://www.w3.org/2002/06/wsdl/http
ogsi	http://www.ggf.org/namespaces/2003/03/OGSI
sd	http://www.ggf.org/namespaces/2003/02/serviceData
wsdl	http://schemas.xmlsoap.org/wsdl/
wsp	http://schemas.xmlsoap.org/ws/2002/12/policy
xsd	http://www.w3.org/2001/XMLSchema
xsi	http://www.w3.org/2001/XMLSchema-instance

3. Specification Overview

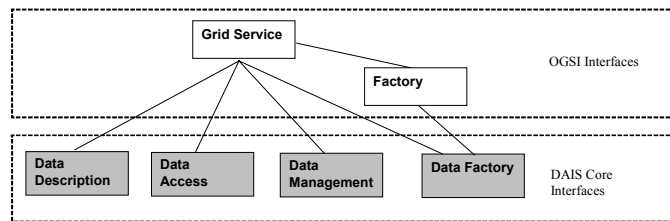
3.1 Scope of Specification

In this document the DAIS Working Group specifies the portTypes *DataDescription*, *DataAccess* and *DataFactory* introduced by the *OGSA Data Services* document [Data Services]. The portType *DataManagement* has not been considered fully, but information relating to discussions to date is retained in Section 9.

This document does not describe how the portTypes specified should be composed into services and implemented.

3.2 Port Type Summary

The *OGSA Data Services* [Data Services] document describes a Grid service based approach to providing Grid access to Data Resources. Four base portTypes categorize a Data Service's interface. These are summarized below.



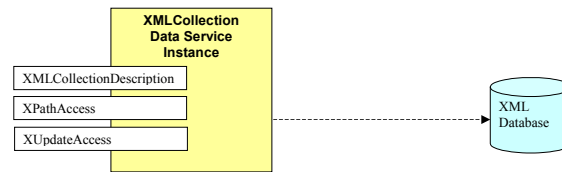
PortType	Description
Data Description	Describes the contents and structure of the Data Service.
Data Access	Provides access to data in the Data Service.
Data Factory	Creates derivations of a Data Service in the context of a valid agreement.
Data Management	Manages the Data Service and its relationship with the underlying Data Resource.

Although the base portTypes are defined in outline in the *OGSA Data Service* document they are not actually specified there. It is the purpose of this document to define a data model independent version of these interfaces. Companion documents specify further specializations of these interfaces to deal with specific data models, i.e. relational [GD RR] and XML [GD RX].

3.3 Port Type Composition

The *OGSA Data Services* document defines a Data Services compliant Grid service as being a service that implements at least one of the four base portTypes. A Data Service may thus be constructed by implementing, or extending, one or more of the portTypes that the DAIS Working Group defines.

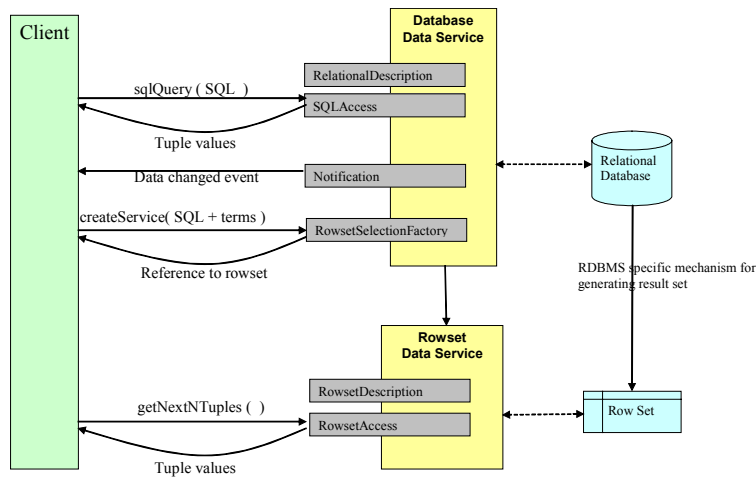
The specification of separate categories of portTypes does not imply that they may be combined arbitrarily. PortTypes should be combined in a way that is relevant to the semantics of the data access that a Data Service represents. For example:



This example shows a Data Service providing **XPathAccess** and **XUpdateAccess** portTypes for access to an XMLCollection Data Service that, in this case, is associated with an XML Database. The **XMLCollectionDescription** portType provides information about the XML Collection Data Service.

3.4 Data Services Derivations

The ability to derive one Data Service from another to provide different views of the same Data Resources leads to a collection of notionally related Data Service instances. For example:



The **Database Data Service** in this example presents an **SQLAccess** portType for interactions with the Relational Data Resources in which a request returns its results to the client directly. A client may also register with the Data Service to receive notifications. The **createService** operation in the **RowsetSelectionFactory** portType is used to construct the derived **Rowset Data Service**. This service provides access to the RowSet resulting from an SQL query against a Relational Database. The RowSet is a subset or restriction of the data in the database and is presented in tabular form. The RowSet could be stored as a table in a relational database or decoupled from the database, but the important distinction here is that the data is represented as a collection of rows that does not implement the **SQLAccess** portType. Instead the **Rowset Data Service** presents the **RowsetAccess** portType that allows rows to be retrieved but does not provide facilities for submitting SQL queries.

4. Interface Design Principles

In this specification, a position is taken on a number of interface design principles. This position is described here and presented in the portTypes that form the DAIS Working Group specifications. They are presented here in this section for convenience but may be moved in the future to a companion document.

4.1 Data Service Artifact Relationships

The DAIS Working Group assumes the following relationships between artifacts identified in the OGSA Data Services document.


- One or more portTypes are exposed by one Data Service instance.
- One Data Service interacts with one or more Data Resources.

DAIS compliant services MUST implement at least one of the DAIS specified portTypes.

4.2 Data Service Creation

4.2.1 Overview

Each Data Service instance, through its GSH, is uniquely named with an appropriate interface for its intended use. For example, it may be desirable:

- To create a new Data Service from an existing Data Service to represent a derived view of the original data.
 - For example, a Data Service representing an RDBMS could be used to create a new Data Service which represents just one of the databases in the RDBMS.
-  create a session in which to perform asynchronous operations against a Data Service.
 - For example, a long running query.
- To create an unpopulated Data Service to which new data can subsequently be added.
 - For example, an empty file handle to which content can be added.

The Data Factory portType, through the portTypes that extend it, is expected to be the primary mechanism by which one Data Service is explicitly created from another.

4.2.2 Explicit Factories

Where Data Factory interfaces are defined, they will support Data Service creation in the context of terms explicitly passed to the createService operation. These terms will be replaced by the use of a WS-Agreement document once this specification has been accepted as a standard.

The creation of Data Services is sufficiently complex to make the precise naming of Factory portTypes difficult. For example, factory portTypes could include in their naming scheme an indication of what terms need to be supplied to characterize the new service instance and/or what type of service they can create. The DAIS Working Group has adopted the position that Factory portTypes should be named in accordance with the type of Data Access expressions that may be used to define the scope of the resulting Data Service. For instance an SQLFactory can receive an SQL expression that can be used to populate the Data Service that the Factory interface will create.

The creation of a Grid Data Service by a Data Factory can be considered a two-stage process,

1. Creation of a service providing the required operations/port types.
2. Materializing the data behind the Data Service (e.g. for SQLFactory the results of the SQL Query).

The handle for this new service is returned at the end of step 1. Step 2 occurs asynchronously with respect to the Factory. The willingness of a Data Service to accept Data Access operations is indicated by the status SDE of the Data Access portType.

Characteristics of the newly created Data Service, as defined by the terms passed to the createService operation, may dictate variations on this service creation theme. For example, a data service may or may not hold data values after transaction commit.

The Factory::createService() operation returns a handle to one Grid service. If the result of a creation request is more than one Data Service then these must be grouped together and the handle to the group returned from the createService operation.

4.2.3 Implicit Factories

This specification does not make use of implicit factories, i.e., operations other than Factory::createService() that create service instances.

4.3 Query Expression Types

In a Data Access service that virtualizes query results using Data Services, one of the parameters passed to a createService operation may be that a query expression describing the data that is to be represented by the created Data Service. The same structures and types to represent expressions wherever they appear. For example the XPathQuery operation in the XPathAccess portType might define an input message as follows:

```
<xsd:complexType name="XPathExpressionType">
  <xsd:sequence>
    <xsd:element name="expression" type="xsd:string"/>
    <xsd:element name="collection" type="xsd:string" minOccurs="0"/>
    <xsd:element name="resourceId" type="xsd:string" minOccurs="0"/>
  </xsd:sequence>
</xsd:complexType>

<message name="XPathStatementInputMessage">
  <part name="expression" type="daixml:XPathExpressionType"/>
</message>
```

Using this approach, common types can be used in Data Access operations and in createService.

4.4 Access Control

The possibility of many client processes accessing a Data Service interface, possibly concurrently, is assumed to be the default situation.

Access to a Data Service may be denied, where appropriate, using suitable access mechanisms either at the service or the underlying Data Resource. Each call to an operation comes with a security context and the call is accepted as long as the context is allowed. For example, a system representing a relational database may wish to restrict access to the Data Services representing RowSets to the client that created those Data Services.

4.5 Operation Validity

The DAIS Working Group specification groups operations and SDEs in accordance with the type of Data Resource to be accessed. The appearance of an operation in a portType does not guarantee that it may be validly called in any particular situation. Faults are provided to notify the caller that an operation could not be completed successfully.

4.6 Data Formats

Data Access portTypes define operations for retrieving data from and adding data to Data Resources. By default such operations strongly type the parameters and return types that hold this data. As an alternative, the DAIS Working Group specifications also support a mechanism for dynamically typing data passing into and out of Data Access operations. Using this approach

can reduce the combinatorial effect of variable expressions, input and return types on operation and portType naming.

A DataSet type is defined which wraps data along with a type description. This type is used as the input or output type for operations where variable types are required. DataSets are currently being scoped by members of the DAIS Working Group and may form future input to this Working Group.

An SDE, dataFormats, defined on the base Data Access portType, lists the data formats that the service is able to process and produce.

4.7 Sessions

A single client's session can be modeled as a Data Service, which is accessible by only that client. Alternatively, session semantics can be obtained by defining context to be passed to Data Access operations.

4.8 Data Service Management

The addition and removal of artifacts from a Data Service is considered to be a Data Management portType activity. For example, the addition of two files to a file based Data Service that represents them as a contiguous set of data.

The addition and removal of artifacts from some Data Resource that is represented by a Data Service are considered to be a Data Access activity. For example the addition and removal of files from a file system represented by a file system Data Service.

Update operations, for example, addDocuments and removeDocuments from a Data Access portType dealing with XML collections, will be supported in Data Access interfaces in as much that they update the current Data Service.

Any management interfaces described by the DAIS Working Group are aimed at management of the Data Service. Management of the underlying Data Resource is not considered. Data Management portTypes are not yet considered in detail in the DAIS Working Group specifications. However information is collected regarding the types of SDEs and operations that would be expected in this category.

5. Related Standards

5.1 WS-Agreement

WS-Agreement [WS-Agreement] is under development by the GGF GRAAP Working Group. DAIS plans to use WS-Agreement as the basis for the negotiation and agreement of service terms when creating and interacting with a Data Service instance once this specification has been accepted as a standard.

5.2 Metadata

The DAIS Working Group specifications include references to metadata expressed within port types that incorporate Service Data Elements (SDEs), which in turn use XML schema definitions. The specification emphasizes general-purpose metadata for describing and accessing data and metadata in flexible ways. Grid systems do require application specific metadata, even at the data instance level, e.g., to retrieve detailed data instance provenance information. Application-specific metadata will be described in separate specifications.

Some of the general-purpose standards required by the specification appear in other standards documents. For example:

- XQueryRequest as defined in W3C XQueryX [XQueryX].
- WebRowSet format returned to a client, defined in JCP JSR 114 [WebRowSet].

5.3 Notification

Grid applications will generally rely on notifications to support the loosely coupled soft state nature of their construction. This is also true of data Grids. Applications using interfaces defined by the DAIS Working Group specifications will rely on notification of a number of items, including:

- Data creation, update and deletion.
- Schema changes.
- Request progress and completion.
- Service creation and deletion.

Generally implementations MAY be able to act as notification sources for any or all SDEs they implement. Other than that, the DAIS Working Group specifications currently provide no support for other forms of Data Resource notification.

5.4 Transactions

Grid applications will have access to language or requests, such as those described in WS-Transaction [WS-Transaction], to specify: transaction start, transaction end (commit, rollback) and intermediate checkpoints (points to rollback to). Resource managers and Coordinators will have access to language or requests, such as those described in WS-Transaction and WS-Coordination [WS-Coordination] to indicate participation in a transaction, disposition of their part of the transaction. e.g., committed, rolled back, in doubt, etc. In a transactional environment, when a Grid application accesses multiple recoverable resources that support the transaction concept, all resources updated by the Grid application within a single transaction are committed or rolled back. Coordination context tokens flow between the calling application, the resource managers being coordinated and the coordinating system, in accordance with WS-Coordination.

Within the context of this specification, all recoverable Data Services that can be coordinated in transactions are managed by recoverable Data Resources such as database managers. This specification does not introduce additional recoverable resources outside the domain of the Data Resources it describes how to access through Grid services.

There are a variety of possible transaction options for Grid data access. For example:

- Each Data Access request executes in a separate transaction.
- Multiple Data Access requests to a single Data Service execute in a single transaction, but requests across multiple Data Services are not coordinated. Here the Data Service must expose transaction control requests, but a separate coordinator system is not required.
- Multiple requests to multiple Data Services are coordinated. To support this scenario, a single transaction context must be transmitted through multiple Data Services.

While further investigation is required to define the full range of transaction support and its impact on the DAIS Working Group specifications the following holds.

By default the interfaces assume no transaction support. However, if there is a transactional schema, as indicated by the use of a service term directed at the Data Service, then the transactional context is assumed to be passed to the relevant operations (whether the transaction is local or distributed). Each operation is assumed to act in accordance with the transactional scheme.

5.5 Security

There are many aspects to security for data access in a Grid, e.g., database access security, service access security. In general, the DAIS Working Group specifications will adopt the mechanisms specified by the GGF OGSA Security Working Group. There are areas of security that DAIS or a related data specification will consider in the future, e.g., for linking OGSA security with underlying database security and for mapping database users to Grid users.

5.6 Information Dissemination

The provision of services that provide flexible, high level distribution of data, using both push and pull models, is beginning to be addressed within the GGF [InformationDissemination]. It is anticipated that portTypes defined in the Information Dissemination specification will be used by other Data Services to support flexible and efficient data movement.

5.7 GGF Data Area: OREP-WG

The OREP-WG is anticipated to use the DAIS Working Group Data Services portTypes to provide access to/from sources and sinks at the ends of the replication.

5.8 GGF Data Area: GridFTP

The GridFTP-WG is anticipated to use the DAIS Working Group Data Services portTypes to provide data access to/from data sources and sinks at the ends of the transfer.

5.9 OASIS: WSDDM

Potentially provides a home for the Data Resource management issues and interfaces that the DAIS Working Group will not address.

5.10 GGF Information Systems and Performance Area: CMM-WG

Potentially provides a home for the Data Resource management issues and interfaces that the DAIS Working Group will not address.

5.11 GGF Information Systems and Performance Area: CGS-WG

The CGS-WG is currently defining CIM based models for Grid resources. The DAIS Working Group is working with the CGS-WG to identify how CIM, or extensions to CIM, could be useful in DAIS specifications [DAISCIM].

6. DataDescription portType

DataDescription defines SDEs that describe the data artifacts accessed by a particular Data Service.

As this is the base of all specific Data Description portTypes, the SDEs and operations defined here are general across all extensions.

6.1 Service Data Declarations

- name: a name associated with the data represented by the Data Service.
- structure: a description of the structure of the Data represented by a Data Service. The mechanism by which the structure is described must be extensible as it is specific to the data model.
- size: the size, in bytes, of the Data represented by a Data Service.

6.2 Operations

None.

7. DataAccess portType

DataAccess provides operations to access and modify the contents of a Data Service.

As this is the base of all specific Data Access portTypes the SDEs and operations defined here are general across all extensions.

7.1 Service Data Declarations

- **status:** status of the Data Service with respect to data access. An enumeration with the values:

Ready	– The Data Service is ready to be accessed.
Initializing	– The Data Service is not ready to be accessed.
Error	– An error has occurred which has left the Data Service in an error state.
- **terms:** the values of the terms that characterize the behaviour of the service, as described in Section 8.1.
- **dataFormat:** the data formats that may be used to represent values retrieved by the portType.

7.2 Operations

None.

8. DataFactory portType

DataFactory supports a request to create a new Data Service whose data is derived from the data of the parent Data Service (the one that implements the DataFactory).

As this is the base of all specific Data Factory portTypes, the SDEs and operations defined here are general across all extensions.

8.1 Inherited Service Data Declarations

The set of values of this SDE describe to the client what service terms may be used for deriving a new Data Service from the current Data Service.

The OGSi Factory portType defines an SDE, `createServiceExtensibility`, which describes the extensibility types that the `Factory::createService()` operation is able to accept. The SDE will define valid service terms.

The following terms can be used to characterize the behavior of a data service:



- **AccessConcurrency:** A data service may be able to participate in the following forms of transaction: none, internal-transaction (internal automatic transaction per operation), atomic-transaction by context (e.g. WS-AtomicTransaction) or distributed-transaction by context (e.g. WS-Transaction).
- **AccessMode:** A data service may support read-only, write-only or read-write access.
- **Holdability:** A data service may hold or not-hold data values over transaction commit. If a request is made to access a value from a service that does not-hold values over transaction commit, the operation faults.
- **IsolationLevel:** A data service may implement the following isolation levels: none (transactions not supported), read uncommitted (SQL99/ANSI level 0), read committed

(SQL99/ANSI level 1), repeatable read (SQL99/ANSI level 2) or serializable (SQL99/ANSI level 3).

- **MaximumResultSize:** A request to a data service may be able to return as the response to a request a value up to a specific size (in bytes). If a request is made that generates a result that is greater than the maximum result size, the operation faults.
- **OperationConcurrency:** A data service may support sequential or concurrent evaluation of requests.

8.2 Operations

None.

9. DataManagement portType

DataManagement forms the basis of a set of portTypes used to manage Data within Data Services. In doing this it controls the interface between the real and service worlds. The interface generally contains monitor and control pairs and deals with issues orthogonal to data access.

9.1 Service Data Declarations

- **version:** a structure containing version information available from the underlying Data Resources that is exposed by the Data Service.
- **lastModified:** a timestamp indicating the point at which the data was changed through this Data Service.
- **dataResource:** information about a Data Resource that this Data Service references.
- **roleMapping:** a mapping from a Grid role to a database role.

Further management Service Data Declarations will be defined in later versions of this document.

9.2 Operations

None.

10. Security Considerations

The Realisations of a Grid Data Service will use standard Grid security mechanisms as specified by OGSA Security working group combined with standard ways of relating Grid credentials and authorities to resource access rights. The assumption is that these standards will also indicate how to make information related to authentication, authorization security etc available.

11. Conclusions

This document has described a proposal for a collection of Data Services, which are extended in companion documents to provide support for multiple data storage paradigms. The services proposed are Grid services, in that they conform to and make use of the Open Grid Services Infrastructure [OGSI]. This is a work in progress, and feedback is welcomed on this document.

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Page: 1

[m1] I still think that this statement is not correct - OGSi extends web services while OGSA proposes an architecture.

[MA2] Can we get rid of this term?

[MA3] Do we not want a success or failure return code?