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Evolution of the Replica Location Service Specification to Represent Datasets as Grid Services

Status of This Memo

This memo provides information to the Grid community regarding how the Replica Location Service may evolve in a fully service-oriented architecture. It does not define any standards or technical recommendations. Distribution is unlimited.

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Abstract

We describe issues relating to the evolution of grid service specifications for the Replica Location Service (RLS) to reflect a more service-oriented architecture. In particular, we want to evolve the RLS specification documents previously presented to GGF to reflect recent discussions in various GGF working groups (DAIS, OGSA, etc.) of the need to treat datasets, including files, file systems, databases and virtual data objects, as first-class, OGSI-compliant services.

We explore various strategies for changing or extending the current proposed specifications for the RLS in a service-oriented architecture where datasets are represented as Grid services.

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Introduction

In the context of the OGSA Data Replication Services Working Group (OREP), we propose to evolve the Grid service specifications for the Replica Location Service (RLS) to reflect a more service-oriented architecture. In particular, we want to modify the RLS specification documents previously presented to GGF to reflect recent discussions in various GGF working groups (DAIS, OGSA, OREP, etc.) of the need to treat datasets, including files, file systems, databases and virtual data objects, as first-class, OGSI-compliant services.

Treating datasets as services has the following implications:

- *Global names*. Datasets are uniquely and globally named by Grid Service Handles (GSHs), which are URIs that consist of a scheme followed by a string containing scheme-specific information. This scheme-specific information can be interpreted to resolve the GSH into a Grid Service Reference (GSR) that contains all information a client requires to access the dataset via network protocol bindings. [2]
- *Standard mechanisms for metadata access, lifetime management, etc*. Datasets have all the properties of OGSI services. In particular, they must implement the Grid Service port type and must support core properties of Grid services, including introspection on service data elements and lifecycle management.

The assertion that all datasets should be treated as services may raise concerns about performance. It should be noted that service invocation is not necessarily a heavy-weight operation. We expect service invocation to be optimized as OGSA implementations mature, and future versions of OGSA may incorporate specialized mechanisms for efficient handling of dataset services.

In the following, we explore various strategies for changing or extending the current proposed specifications for the Replica Location Service to take advantage of a representation of datasets as first-class OGSI-compliant Grid services.

1. Grid Service Wrappers around Existing Replica Location Service

The simplest option for using the Replica Location Service in a Grid service architecture is to provide Grid service wrappers around the existing Local Replica Catalog (LRC) and the Replica Location Index (RLI) services. In this option, RLS services would contain mappings between logical and target names that are completely independent of the GSHs that name dataset services. This simple option is reflected in the first version of the Local Replica Catalog specification [3].

This first step allows us to use OGSI-compliant mechanisms to access RLS components, and is thus important as we move towards OGSA-based environments. However, it does not allow us to take advantage of other OGSA machinery within our RLS implementation.

2. LRC Target Names Become GSHs

A first evolution of the existing Local Replica Catalog specification to accommodate a service-oriented treatment of datasets is to store the GSHs of datasets rather than URIs, as at present, in the target entries of LRC mappings. Thus, the LRC would provide mappings from logical names to the GSHs that point to replica datasets. In this scheme, the design of the RLI is unchanged.

This step would allow us to locate datasets that are represented as Grid services but would not allow us to use other OGSA machinery.

3. Use of General Grid Service Indexing Mechanisms

A next extension would replace the specialized LRC and RLI indexes currently envisioned for the Replica Location Service with general Grid service index mechanisms being developed for OGSA. These mechanisms are being developed for use in OGSA information services and throughout the architecture where indexes are required. Typically, an information provider running on a resource collects or summarizes information about that resource and responds to queries from an index service for that information. In this option, a dataset would provide information about itself to an indexing Grid service.

The advantage of this extension is that we exploit commonalities with other OGSA components, rather than having to develop and maintain separate index service implementations for different purposes. However, the successful realization of this step requires that we have general information services that can provide acceptable performance for RLS purposes.

4. Name Space Management Via an Logical Naming Authority

The Replica Location Service currently provides mappings from logical names to target names and optionally associates a set of attributes with those names. One concern that has been raised about the existing draft LRC specification is that the LRC does not provide sufficient access control over who is allowed to register new mappings between logical and target names.

In a service-oriented architecture, the logical name associated with a dataset would become a service data element (SDE) associated with that dataset. One approach for controlling the creation of replicas is to create a Logical Naming Authority that could assert that a mapping that associates a dataset with a logical name is valid by signing the mapping. This signature would be similar to those provided by a Certificate Authority or a Community Authorization Service. Any unsigned mapping between a dataset and a logical name would be considered invalid.

In a system with a Logical Naming Authority, registration of a new replica would require three steps. First, a client that wants to register a new replica mapping would have to request a signed mapping from a Logical Naming Authority with whom the client has a trust relationship. Second, the signed mapping must be associated with the dataset as a service data element (SDE). Finally, the signed mapping must be registered with an LRC.

5. Representing Replica Sets as Services

Another possible extension is to represent not only individual datasets but also sets of replicas as Grid services, so as to benefit from the same OGSI mechanisms (global names, service data, lifetime management) that seem useful for datasets.

The logical names registered in RLS catalogs can be thought of as defining equivalence sets of replicas. In a fully service-oriented design, these equivalence sets of replicas would also be services. These *replicaSet services* are virtualizations of the set of replicas that make up each equivalence class. The GSH for a replicaSet could then be used as the logical name for the replicated dataset.

Such replicaSet services provide a natural point for controlling the registration of new replicas in the equivalence class and effectively serve as Logical Naming Authorities. Thus, the replicaSet service enforces policies for access control as well as replica coherence. The replicaSet service will only allow clients with whom it has an appropriate trust relationship to add new dataset services as members of the equivalence set. In addition, the replicaSet service can enforce a variety of replica coherency policies, ranging from strict consistency (i.e., that all datasets registered as members of the replicaSet are exact copies of one another) to more relaxed consistency semantics (e.g., that all versions of a data item are considered replicas or that

members of the equivalence class are “similar” according to some definition or policy of similarity).

A client may directly inspect a replicaSet, which must respond to queries about its service data, including information about its members.

The fact that replicaSets can answer queries about their own members means that we no longer require the LRC and RLI services of the current RLS design from a functionality perspective. However, providing such indexes may be useful for performance and reliability reasons, since aggregating information about replicaSet services can allow for far more efficient discovery of replica dataset services. In this architecture, the LRC and RLI services have similar functions and may be combined into a single RLS service that indexes replicaSet entries, responds to queries about its members and provides summaries of the index’s content to a higher-level index in a hierarchy.

6. ReplicaSets and/or Indexes Implemented as ServiceGroups

In a service-oriented architecture, a *replicaSet* that represents an equivalence set of replicated datasets could be implemented as a *ServiceGroup*. As defined in the OGSI specification [2], a ServiceGroup is a Grid service that maintains information about a group of other Grid services. ServiceGroup entries consist of a locator of the member service and content information describing the member service. The advantage of implementing replicaSets as service groups is that we would make use of ongoing development of service group port types, including using the add and remove methods of the ServiceGroupRegistration port type for managing entires of a replicaSet service.

LRC/RLI catalogs used for indexing and aggregating information about replicaSets could also be implemented as ServiceGroups.

7. GSH Resolution

An additional issue for a service-oriented architecture is how handles (GSHs) of datasets and/or replicaSets get mapped to GSRs, which are references that contain all information needed to communicate with a service instance. A resolver might simply be a table that contains mappings from GSHs to GSRs. However, such a centralized implementation would not scale well as the number of entities in a distributed system grows. A more distributed, scalable resolver implementation could be based on an architecture similar to that of the existing Replica Location Service. This implementation would consist of local catalogs (similar to LRCs) that contain mappings from GSHs to GSRs and aggregating index nodes (similar RLIs) that aggregate GSH lookups and identify the correct local catalog(s) for handle resolution.

8. Next Steps

We propose that the OREP Working Group should move toward producing a specification for a fully service-oriented Replica Location Service, as described in Sections 5 and 6 above. The evolution of the RLS could occur incrementally or all at once, according to the consensus of the working group.

Necessary steps along the path toward a fully service-oriented solution include the following:

- In cooperation with the DAIS Working Group and possibly other GGF groups, produce a data model and grid service specification for dataset services, including their service data elements and port types.

- Produce a grid service specification for replicaSet services, including their service data elements and port types. Determine whether these services should be implemented as OGSI ServiceGroups.
- Produce a grid service specification for RLS index services based on OGSA indexing mechanisms. Determine whether these indexes should be implemented as OGSI ServiceGroups.

9. Security Considerations

This discussion relates to OGSI-Compliant grid services for replica location. Therefore, our service will have all the same security capabilities and issues as other OGSI-compliant services. Additional security considerations such as access control over creation of replica mappings are discussed in Sections 5 and 6 of this document.

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