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GLUE v. 2.0 – Reference Realization to XML Schema

Status of This Document

This document provides information to the Grid community regarding the realization of the GLUE information model (v.2.0) as XML Schema. Distribution is unlimited. This realization is derived from the proposed recommendation of the specification document [glue-2].

Please note, the XSD is provided at the end of the document from page 25 to page ~66 (you may only want to print the first 25 pages).

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Abstract

The GLUE 2 specification is an information model for Grid entities described in natural language enriched with a graphical representation using UML Class Diagrams. This document presents a realization of this information model as XML Schema.

Contents

1. About this Document

The GLUE 2.0 Information model defined in [glue-2] is a conceptual model of Grid entities. In order to be adopted by technology providers, a realization in terms of a concrete data model is needed. This document provides the normative realization of the GLUE 2.0 conceptual model in terms of an XML Schema (XSD). The document also elaborates on the design choices adopted to map the entities and relationships of the conceptual model into the concrete data model.

This document is maintained by OGF's GLUE Working Group, which signs responsible for documenting errata and releasing revisions as defined by the OGF document process. Errors and feedback in general should be directed to the GLUE WG mailing list, at `<glue-wg@ogf.org>`.

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].

3. XML Schema Realization

There are many possible approaches to map the GLUE 2 conceptual model into an XML schema. Depending on which aspects are important, different design choices are preferable. The core design characteristics of this rendering include:

- A single Document Root element (`Entities`), which serves as a global element bag (see Listing 1).
- `Entities` nests child elements as siblings in an established order. The nested child elements represent the core GLUE 2 entity classes. The multiplicity of all the entity elements is zero-to-many.
- Associations between sibling elements are modeled using ID Reference (Ref) elements rather than nesting elements into parent-child relationships. There are a number of functional justifications for choosing a flat document style over a nested/hierarchical style described in Section 3.5.
- To fully implement the GLUE 2 conceptual model, the XSD defines a number of abstract elements that correspond to the GLUE 2 abstract entity classes. These abstract elements allow different (concrete) element implementations to be derived and substituted into the document. For example, `Service`, `ComputingService` and `StorageService` may substitute for `AbstractService`. The element implementations that are valid according to this schema are given in Listing 1. Abstract element inheritance is described in Section 3.6.
- Importantly, new element specializations that can substitute for the core abstract classes may be profiled and nested within `Entities` without requiring subsequent modification to this schema. The process for importing this XSD and deriving custom element specializations is described in Section 3.7
- All entity elements are defined globally within the XSD. In doing this, the GLUE 2 entity elements can be imported and reused within other XML documents without having to conform to the constraints and ordering defined by `Entities`.
- Additional elements defined in other namespaces can be nested in pre-defined extension points as described in Section 3.8.

3.1   Namespace

The Open Grid Forum has provided guidelines for uniquely identifying uniform names in the GGF/OGF domain [ogf-ns]. Based on this document, we have adopted the following namespace for the XML Schema realization of GLUE 2.0:

```
GLUE-XSD-NS ::= 'http://schemas.ogf.org/glue/' YYYY '/' MM '/spec_' M.N '_r' R
```

- `YYYY`: year of the normative document of the GLUE specification
- `MM`: month of the normative document of the GLUE specification
- `M.N`: M is the major version and N is the minor version of the GLUE conceptual model
- `R`: component to be used to specify the revision number of the XSD realization; this number SHOULD be incremented each time a new non-backwards compatible version is published

As a non-normative example, the namespace for the first release of the XSD document for the final GLUE 2.0 specification [glue-2] is:

```
http://schemas.ogf.org/glue/2009/03/spec_2.0_r1
```

3.2   Document Root Element (`Entities`)

- `Entities` is the only recognised Document Root element. For full interoperability, instance documents MUST define `Entities` as the Document Root.
- Entity elements are nested as siblings in an order which is determined according to the location of abstract super-class elements defined within `Entities`.
- Entity elements that have no abstract super-class are placed according to their specific location within `Entities`.
- Different concrete elements MAY substitute for an abstract super-class in an unspecified order. For example, when substituting for the abstract `Domain` class, `AdminDomain` may appear before `UserDomain` and vice-versa.
- Abstract class substitution imposes an element ordering which is more loosely defined compared to ordering by concrete elements. However, in doing this:
  - New entity specializations may be conveniently substituted into predictable locations according to the placement of abstract classes.
  - This provides a more strict element ordering compared to substituting new implementations in place of `xsd:any` extension points.
  - Abstract classes allow newly derived entities to be equal siblings within `Entities`.
- The multiplicity of all entity elements within `Entities` is zero-to-many.
- An instance document with a single `Entities` element MAY aggregate resources belonging to different clusters and grids. Alternatively, an `Entities` document MAY restrict resources to those belonging to the same grid/cluster. This is a rendering style choice and is left to the requirements of the implementation. Of course, the XSD described in this document can be imported into a parent schema in order to define a list of `Entities` nested within a single (outer) document root element, where each `Entities` element could, for example, separate resources according to grid/cluster.

Listing 1. Simplified GLUE 2 XML document structure. `Entities` is the document root element which nests entity elements as siblings in a pre-defined order. Entity elements are ordered according to the location of abstract elements defined within `Entities`. Entity elements that have no abstract super-class are placed according to their specific location. (*) signifies a zero-to-many multiplicity.

```xml
<Entities>
        <!-- Locations and Contacts first: -->
        <Location/> *
        <Contact/> *
        <!—
        Abstract elements are defined in the XSD in the following order
        (note, different concrete elements MAY substitute for an abstract
        class in an unspecified order):
            <AbstractDomain/>
            <AbstractService/>
            <AbstractEndpoint/>
            <AbstractShare/>
            <AbstractManager/>
            <AbstractResource/>
            <AbstractActivity/>
            <AbstractPolicy/>
        -->
        <!-- Elements that implement <AbstractDomain/> : -->
        <AdminDomain/> *
        <UserDomain/> *
        <!-- Elements that implement <AbstractService/> : -->
        <Service/> *
        <ComputingService/> *
        <StorageService/> *
        <!-- Elements that implement <AbstractEndpoint/> : -->
        <Endpoint/> *
        <ComputingEndpoint/> *
        <StorageEndpoint/> *
        <!-- Elements that implement <AbstractShare/> : -->
        <ComputingShare/> *
        <StorageShare/> *
        <!-- Elements that implement <AbstractManager/> : -->
        <ComputingManager/> *
        <StorageManager/> *
        <!-- Elements that implement <AbsractResource/> : -->
        <ExecutionEnvironment/> *
        <DataStore/> *
        <!-- Elements that implement <AbstractActivity/> : -->
        <Activity/> *
        <ComputingActivity/> *
        <!-- Elements that implement <AbsractPolicy/> : -->
        <AccessPolicy/> *
        <MappingPolicy/> *

        <!-- Other concrete element references with no
             abstract super-class: -->
        <Benchmark/> *
        <ApplicationEnvironment/> *
        <ToComputingService/> *
        <ToStorageService/> *
        <StorageAccessProtocol/> *
        <StorageServiceCapacity/> *
        <StorageShareCapacity/> *
        <ApplicationHandle/> *
        <xsd:any/> *
</Entities>
```

3.3   Entity Elements

- Each UML class (or 'Entity' in GLUE 2 nomenclature) of the conceptual model maps into an XML element definition as an 'entity element'. These are given in Listing 1. For a comprehensive description of the attributes and semantics of each entity, please refer to the conceptual model [glue-2].
- In general, each attribute of a UML class in the conceptual model maps into an XML element definition (this is a general rule and applies also to both `ID` and `LocalID` attributes); an exception is made for the attributes `CreationTime` and `Validity` of the `Entity` class. Since they can be considered as metadata about GLUE-based description of entities, they are modeled as XML attributes.
- If a class or an attribute can be instantiated multiple times, then a separate XML element for each instance MUST be created.

As additional information, it should be noted that:

- Attributes whose type is a timestamp are defined using `glue:DateTime` which is `xsd:dateTime` simple type. Unlike the conceptual model, the UTC Timezone is not restricted to the following pattern for marshaling/un-marshaling and interoperability reasons: `yyyy'-'mm'-'dd'T'hh':'mm':'ssZ`.
- If an information producer cannot define a value for a mandatory attribute, then you SHOULD use the placeholder values defined (see Annex A in [glue-2])

3.4   Enumerations

The GLUE 2 specification defines a set of attributes that form an enumeration. These enumerations belong to two main categories:

- Closed enumerations: a restricted list of values where the value of the attribute MUST belong to the set of defined values.
- Open enumerations: an unrestricted list of values where the value of the attribute MAY be one of the provided values OR an un-defined value. The available list of values simply gives the receiving system a hint as to known values, but in fact any string value can be used.

3.4.1   Closed Enumerations

Closed Enumerations are modeled as restrictions on a base type. By using the element `enumeration`, each allowed value is explicitly defined. An element whose type is a restricted string is valid if and only if the value matches one of the defined enumeration values. Listing 2 shows an XSD fragment that defines the enumeration for the `Endpoint HealthState` attribute:

Listing 2. Sample schema for a Closed Enumeration type with a limited value range (`Endpoint HealthState` attribute).

```
<simpleType name="EndpointHealthState t">
  <restriction base="string">
      <enumeration value="critical"/>
      <enumeration value="ok"/>
      <enumeration value="other"/>
      <enumeration value="unknown"/>
      <enumeration value="warning"/>
  </restriction>
</simpleType>
```

3.4.2   Open Enumerations

Open enumerations are modeled using the XSD `union` construct [xsd-oe, xsd-ap]. The union is used to combine a free-form `string` with an `enumeration` of suggested values. This is shown in Listing 3 which defines an open enumeration for the `DataStoreType` attribute. Software validating an XML document SHOULD be instrumented in order to consider the provided values. Addition or removal of enumeration values to/from an open enumeration does not break backward XSD compatibility. Therefore implementations MAY add or remove values as required.

Listing 3. Sample schema for an Open Enumeration type (`DataStoreType` attribute).

```
<simpleType name="DataStoreType_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="disk"/>
                <enumeration value="optical"/>
                <enumeration value="tape"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>
```

3.5   Associations

In the conceptual model, several association types are represented. They can be classified in terms of the multiplicity (one-to-one, one-to-many, many-to-many), in terms of the navigability (bi-directional, unidirectional) or in terms of the association type (binary, aggregation, composition, association class).

3.5.1   Associations Elements and ID Reference Elements

Associations are modeled using ID Reference (Ref) Elements which define foreign keys between entities:

- An ID Ref Element is used to reference another entity by specifying the unique value of the referenced entity's `ID` element.
- ID Ref elements are grouped together under each entity's mandatory `Associations` element.
- If a given entity has no mandatory relationships, `Associations` MAY be empty provided the entity has no instances of optional relationships. An empty `Associations` element is shown in Listing 4 which defines an orphan `Contact`. By mandating `Associations`, the entity's relationships are clearly defined. If `Associations` was made optional, it would be possible to erroneously omit the `Associations` element even if relationships existed. If an entity element has associations, then the corresponding ID Ref elements MUST be rendered.
- A bidirectional association between two entities is modeled using two ID Ref elements (one placed in each entity) to establish the relationship on both sides of the association.
- A unidirectional relationship is modeled using a single ID Ref element in the entity that 'owns' the relationship.
- An association with a 'many' multiplicity is modeled using multiple ID Ref elements.

Listing 4. The `Associations` element must always be rendered in an entity element. `Associations` MAY be empty if no mandatory associations exist.

```
<Contact>
    <ID>urn:contact1</ID>
    <Detail>http://some.uri/embedding/contact/info</Detail>
    <Type>general</Type>
    <!-- Orphan contact (Associations must still be rendered) -->
    <Associations/>
</Contact>
```

ID Ref elements are named according to the following scheme:

- ID Ref elements are named after the abstract-super class of the referenced entity with the suffix 'ID'. This is shown in Listing 5 with the following example:
  - A `ComputingShare` can be linked to many computing endpoints. The resulting ID Ref element is therefore:
    `'//ComputingShare/Associations/EndpointID'` (not `'//ComputingShare/Associations/ComputingEndpointID'`)
  - Similarly, a `ComputingShare` can reference many execution environments. The resulting ID Ref element is therefore:
    `'//ComputingShare/Associations/ResourceID'` (not `'//ComputingShare/Associations/ExecutionEnvironmentID'`)

- If a referenced entity has no abstract super-class, ID Ref elements are named after the referenced element with the suffix 'ID'. For example:
  - A `ComputingManager` may be related to one or more `Benchmark` entities. Therefore, the benchmark association is modeled as: `'//ComputingManager/Associations/BenchmarkID'`

- Naming an ID Ref element after the abstract-super class of the referenced entity caters for a well-defined use case: It allows standard queries to be executed on an instance document regardless of the referenced entity sub-type. This is shown in Listing 6 - the first XPath query can be used to select the ID values of all the service endpoints, excluding orphan endpoints, irrespective of the particular endpoint type. The second XPath query can be used to select the ID values of all the services that are related to the endpoints, irrespective of the particular service and endpoint types (note, these queries utilize the `BaseType` attribute described in Section 3.6.3).

- The conceptual model defines a number of recursive relationships that are bi-directional. For example, an `AdminDomain` may aggregate zero or more child `AdminDomainS`. Respectively, a child `AdminDomain` may reference its parent `AdminDomain`. In these cases, the ID Ref elements are prefixed with 'Parent' or 'Child' in order to distinguish between the different types of relationship (in this case `ParentDomainID` and `ChildDomainID`).

Listing 5. Associations between entities are modeled using ID Reference elements which are nested within an entity's mandatory `Associations` element. An ID Ref element refers to the `<ID>` value of the related entity. ID Ref elements are named after the abstract-super class of the referenced entity with the suffix 'ID'. If a referenced entity has no abstract super-class, ID Ref elements are named directly after the referenced element with the suffix 'ID'.

```
<Entities ...>
   ...
   <ComputingService BaseType="Service">
        <ID>urn:myservice1</ID> ...
   </ComputingService>

   <ComputingEndpoint BaseType="Endpoint">
        <ID>urn:myendpoint1</ID> ...
   </ComputingEndpoint>

   <ComputingEndpoint BaseType="Endpoint">
        <ID>urn:myendpoint2</ID> ...
   </ComputingEndpoint>

   <ComputingShare BaseType="Share">
        <ID>urn:mycomputingsshare1</ID>
        <ServingState>production</ServingState>
        <Associations>
            <EndpointID>urn:myendpoint1</EndpointID>
            <EndpointID>urn:myendpoint2</EndpointID>
            <ResourceID>urn:myexenv1</ResourceID>
            <ServiceID>urn:myservice1</ServiceID>
        </Associations>
    </ComputingShare>

   <ExecutionEnvironment BaseType="Resource">
        <ID>urn:myexenv1</ID> ...
   </ExecutionEnvironment>
  ...
</Entities>
```

Listing 6. Naming ID reference elements after the abstract-super class of the referenced entity facilitates generic XPath expressions. In this example, the use of 'EndpointID' and 'ServiceID' (rather than more specific 'ComputingServiceID' or 'ComputingEndpointID') allows queries to select all sub-types irrespective of the particular service and endpoint specializations.

```
/Entities/*[@BaseType='Service']/Associations/EndpointID/text()
/Entities/*[@BaseType='Endpoint']/Associations/ServiceID/text()
```

3.5.2   Traversing Associations and Document Validation

ID referencing requires the associations are checked for correctness during document validation. To do this, the element IDs identified in each `Associations` element must be cross referenced to ensure they refer to the expected element types. This extra validation step is not enforced by the XSD schema. For example, it is necessary to check that a `//ComputingService/EndpointID` element correctly references a `ComputingEndpoint` instance. If the referenced element is not of the required type for the implementation, then an error MUST be returned. To assist with type checking when cross-referencing, the XSD provides type-hints described in the next section.

3.5.3   Type Hinting in ID Reference Elements

The XSD definition of each ID Reference element may define one or more '`//annotation/appinfo`' elements whose values specify *which* type of element SHOULD normally be referenced (i.e. the expected type of the referenced element). The `appinfo` elements provide hints for the software that validates an XML document as the XSD does not enforce ID cross-reference type checking. Therefore, implementing systems SHOULD be instrumented in order to consider the `appinfo` values. The format of the `appinfo` element value is defined using the '`refType:`' prefix appended with the name of the referenced element. This is shown in Listing 7.

Listing 7. The XSD definition of ID Reference elements may contain type hints as to the expected type of the referenced entity using `appinfo` annotations. In this example, the `Benchmark` entity may reference one `Resource` (an expected `ExecutionEnvironment`) and one `Manager` (an expected `ComputingManager`).

```
<complexType name="Benchmark_t">
...
<element name="Associations" minOccurs="1" maxOccurs="1">
  <complexType>
    <sequence>

      <element name="ResourceID" type="glue:ID_t"
        minOccurs="0" maxOccurs="1">
       <annotation>
          <appinfo>refType:ExecutionEnvironment</appinfo>
       </annotation>
      </element>

      <element name="ManagerID" type="glue:ID_t"
        minOccurs="0" maxOccurs="1">
       <annotation>
        <appinfo>refType:ComputingManager</appinfo>
       </annotation>
      </element>

    </sequence>
  </complexType>
</element>
...
</complexType>
```

3.5.4   Document Style Choice - Flat vs. Nested

The flat document style was chosen over a hierarchical approach for the following reasons:

- The GLUE 2 information model is not a strict tree structure. Elements with multiple parents and many-to-many relationships cannot be modeled by nesting alone. In these types of relationship, either element duplication or mixing both element ID references with nesting is necessary. For example, if the class participating in the "many" side of the relationship also participates in other associations, then only one of those associations can be mapped into a nested parent-child relationship. The other relationships must be modeled using element ID references. This style mixing adds considerable complexity. Conversely, modeling associations using ID reference elements alone produces no such limitations and is consistent.

- Element nesting defines a strong parent-child relationship, where the life span of the child is strongly linked to that of the parent (UML composition). However, the entity relationships in GLUE 2 represent weaker UML aggregations where entities can exist in isolation with their own independent life spans. This is better suited to the ID referencing approach.

- The flat style is more efficient when rendering the results of projection queries. Projection queries 'slice' the data and specify which information should be returned in the result set. In SQL queries, columns are typically specified but in our case we select entities, for example 'select from Endpoint where Endpoint.Type = 'X'). The efficiency advantage is enabled by the loose coupling of ID reference elements:

    o ID reference elements are lightweight – they establish that an element *has* immediate relationships with other elements without having to fully populate and render those elements.
    o Conversely, the nested approach must fully render its child and parent elements in order to show that these relationships actually exist. Fully populating those relations would be required for the sake of completeness; if a related element was not fully populated, the data would be incomplete and subject to misinterpretation (elements MUST always be rendered in full including their immediate relationships). Therefore, the nested approach is largely recursive and so would require cascading to all decedents and ancestors in an entity graph.

- Minimizing XML bloat is important, especially when considering potentially thousands of entities listed by an information system in a large scale grid. Since the flat style is more efficient, it is more suitable for use by information systems which are the intended primary implementations of this schema.

- The loose coupling provided by element ID references means that query results can be split across multiple documents. For example, one Entities document could provide a list of service endpoints while another Entities document could provide contact information. This allows potentially sensitive information to be split into different documents. This would not be possible using nesting which defines strong parent-child relationships (composition) where all relations need to be captured in a single document for the sake of completeness (as described above).

3.6   Inheritance

The main entity classes described in the conceptual model are modeled as abstract XSD elements. Abstract elements serve as global extension points and cannot be directly created in an XML instance document. For each abstract element, one or more implementation elements defined in the GLUE 2 namespace can be substituted in place of the abstract element. The abstract elements and their corresponding GLUE 2 implementations are listed in Table 1.

The following sections describe in detail how inheritance has been implemented in this schema:
- To inherit from an abstract GLUE 2 element, an implementing element must derive from the same base type as the abstract element (see 3.6.1).
- If the implementing element is also intended to be a substitute for the abstract element, it must also name the abstract element in a `substitutionGroup` attribute (see 3.6.2).

3.6.1   Abstract Element Base Type

Elements that substitute for a GLUE 2 abstract super-class element must be derived from the same base type as the abstract element. This is enforced by the GLUE 2 XSD rule set. For example, as shown in Listing 8, all implementations of `AbstractService` must be derived from the `ServiceBase_t` complex type.

The rules of this schema require a deriving element to implement;
- a) All the mandatory elements and attributes defined by the abstract base type.
- b) All the mandatory elements and attributes added by the extending sub-type.
- c) Selected optional elements and attributes added by the extending sub-type (if any).

Table 1. Abstract elements and their corresponding (GLUE2) implementations. Each abstract element has a specific base type and also defines a fixed `BaseType` attribute. This attribute is inherited by all implementations.

Abstract Element Name	Abstract Element Type	BaseType Attribute Value	GLUE 2 Implementation Elements
AbstractDomain	**DomainBase_t**	**Domain**	AdminDomain UserDomain
AbstractService	**ServiceBase_t**	**Service**	Service ComputingService StorageService
AbstractEndpoint	**EndpointBase_t**	**Endpoint**	Endpoint ComputingEndpoint StorageEndpoint
AbstractShare	**ShareBase_t**	**Share**	ComputingShare StorageShare
AbstractManager	**ManagerBase_t**	**Manager**	ComputingManager StorageManager
AbstractResource	**ResourceBase_t**	**Resource**	ExecutionEnvironment DataStore
AbstractActivity	**ActivityBase_t**	**Activity**	Activity ComputingActivity
AbstractPolicy	**PolicyBase_t**	**Policy**	AccessPolicy MappingPolicy

3.6.2   Substitution Groups

To substitute a GLUE 2 abstract element, an element must first derive from the same base type as the abstract element (as described in the previous section), and second it must also name the abstract element in a substitutionGroup attribute.

A substitution group is an extensible element group where other elements can declare that they can be substituted wherever the 'head' element appears in the schema. In the GLUE 2 XSD, the 'head' elements are the main abstract elements. The substituting elements are known as the 'members' of the substitution group. An example is shown in Listing 8 - the AbstractService (head) element can be substituted for any of the substitution group members (Service, ComputingService, StorageService) as they all specify the substitutionGroup="glue:AbstractService" attribute.

The XSD substitutionGroup attribute is therefore used to explicitly declare *which* elements are intended to be substitutable for a particular head element. In doing this, a custom abstract element implementation (Section 3.7) may derive from an abstract element in order to inherit its attributes, and can also choose to declare whether it is intended to be substitutable for the abstract (head) element or not.

Listing 8. Members that can substitute for a GLUE 2 abstract element must specify the appropriate xsd:substitutionGroup and derive from the relevant base type. In this example, Service, ComputingService and StorageService all specify AbstractService in the substitutionGroup attribute value and derive from the ServiceBase_t type.

```
<element name="AbstractService" type="glue:ServiceBase_t"
        abstract="true"/>
<element name="Service" type="glue:Service_t"
        substitutionGroup="glue:AbstractService"/>
<element name="ComputingService" type="glue:ComputingService_t"
        substitutionGroup="glue:AbstractService"/>
<element name="StorageService" type="glue:StorageService_t"
        substitutionGroup="glue:AbstractService"/>

<complexType name="Service_t">
    <complexContent>
        <extension base="glue:ServiceBase_t">
            <sequence>...elided...</sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="ComputingService_t">
    <complexContent>
        <extension base="glue:ServiceBase_t">
            <sequence>...elided...</sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="StorageService_t">
    <complexContent>
        <extension base="glue:ServiceBase_t">
            <sequence>...elided...</sequence>
        </extension>
    </complexContent>
</complexType>
```

3.6.3   BaseType Attribute

We also consider the possibility of querying all sub-types of a specific abstract super-class. In order to simplify this type of query, we introduce an XML attribute called `BaseType` whose value is fixed and corresponds to the name of the abstract super-class. As shown in Listing 9, it is possible to define simple XPath queries for selecting all types of Endpoint, Service and Domain regardless of the specific implementation. The `BaseType` attribute is defined for all abstract elements and is therefore inherited by all implementing elements. The `BaseType` attribute values are given in Table 1.

This attribute also simplifies interpretation of an instance document. For example, without this inherited attribute, it would not be immediately clear which abstract super-class an element has derived from without consulting the XSD inheritance model. An alternative approach would be to mandate a naming convention for all inheriting elements (e.g. all Service element implementations must end with the string 'Service'). However, this naming convention could not be enforced across custom sub-type implementations (see Section 3.7) while the `BaseType` attribute is enforced via inheritance.

Listing 9. Sample XPath queries with the `BaseType` attribute.

```
/Entities/*[@BaseType='Endpoint']
/Entities/*[@BaseType='Service']
/Entities/*[@BaseType='Domain']
```

3.6.4   Controlling Element Derivation

In the conceptual model, entity classes inherit directly from other entities. For example, `ComputingService` and `StorageService` inherit from `Service`. To model inheritance in this XSD, entity elements extend a common base type. For example `Service`, `ComputingService` and `StorageService` all inherit from the common `ServiceBase_t` complex base type. This approach was taken to simplify inheritance and precisely control the derivation of `Associations`. It is best explained with an example:

The `ServiceBase_t` is used to define the common attributes that should be inherited by all service implementations. The attributes include `Capability`, `Type`, `QualityLevel`, `StatusInfo` and `Complexity`. `ServiceBase_t` does not however define an `Associations` element. This is intentional;

- Firstly it allows `Service`, `ComputingService` and `StorageService` to precisely control and customize `Associations` as required. For example, each service variant can define more specific type hints and documentation for their nested ID Reference elements.
- Secondly, derived sub-types can add additional attributes and consistently place `Associations` as the last element within the entity element.
- Thirdly, this style provides the necessary flexibility to model associations differently in custom element implementations as described in Section 3.7.2.

While other XSD techniques are available to control derivation, this approach was chosen for its simplicity and extensibility.

3.7   Defining Custom Abstract Element Implementations

If the standard GLUE 2 element set does not adequately describe a Grid information model, the abstract elements can be substituted for new custom sub-type element specializations.

- Alternative element implementations MUST be defined in a new namespace. In doing this, other standards, extending profiles and end users MAY define new substitutable elements that better describe their Grid entities as required. This follows the GLUE 2 conceptual model which was designed to facilitate extension and specialization of the core entity classes within a particular rendering. Indeed, the conceptual model states that for "Grid [entities] requiring a richer set of attributes, specific models MAY be derived by specializing from the [entity] class and adding new properties or relationships."
- Defining new sub-type element specializations allows new information models to be constrained using strongly typed XSD documents rather than solely relying on the loosely typed GLUE 2 extensibility mechanisms (e.g. string based key-value property bags).
- If new sub-type element specializations are defined, XML instance documents will need to be validated against both the base GLUE 2 XSD and the extending XSD schema(s).
- Since new sub-types must be defined under a new namespace, XML instance documents will NOT be GLUE 2 compliant unless those new types are profiled and subsequently recommended as recognised extensions at a later date.

3.7.1   Importing the GLUE 2 Schema to Define Extended Custom Sub Types

In order to derive custom elements that MAY substitute for the GLUE 2 abstract elements, the GLUE 2 schema must first be imported into a third party schema using an `xsd:import`. New elements can then be defined under the new target namespace of the extending schema. A sample import statement is given below. Of course, the value of the `schemaLocation` attribute can be changed to reference a local copy of the GLUE 2 schema as shown below.

Listing 10. Sample XSD import of the GLUE2 schema (the `schemaLocation` attribute can be updated accordingly if you have a locally cached copy as in the example below).

```
<xs:import
   namespace="http://schemas.ogf.org/glue/2009/03/spec_2.0_r1"
   schemaLocation="glue2_2.xsd"/>
```

Once the GLUE 2 XSD is imported, new abstract element implementations can be derived provided they derive from the same base type as the abstract super class (via type extension or restriction) and specify the name of the abstract element using an `xsd:substitutionGroup`.

An example XSD schema that imports the GLUE 2 schema to derive custom sub-types is given in Listing 11. This schema defines the custom `MonitoredXService` type which provides supplementary monitoring information for the service. Notice that the custom `MonitoredXService` specifies the GLUE 2 `AbstractService` element in its `substitutionGroup` and also extends from the GLUE 2 `ServiceBase_t` complex type.

A corresponding XML instance document is given in Listing 12. Notice that the document references both the GLUE 2 XML schema and the extending schema within its document root definition. Also notice that the extending elements are qualified with the 'ext' namespace prefix that identifies the namespace of the extension schema; 'http://www.extensions.ac.uk/sample'. A similar approach can be taken for sub-typing all the other abstract elements whenever necessary.

3.7.2 Custom Associations

The example in Listings 11 and 12 demonstrates an important design feature; an entity's `Associations` element is not inherited from its super class (see 3.6.4). This is intentional and allows the sub-type to define an alternative strategy for modeling relationships. For the purpose of illustration, the custom `MonitoredXService` defines its `MonitoredXEndpoint` as a nested child element (rather than using an ID reference element). Indeed, this could be exploited in future to define an alternative set of GLUE 2 entity elements that use element nesting rather than ID references.

**Listing 11. Sample XSD that imports the GLUE 2 XSD and extends the
`AbstractService` and `AbstractEndpoint` elements with custom implementations. A
corresponding sample XML instance document is given in Listing 12.**

```xml
<?xml version="1.0"?>
<xs:schema version="1.0"
           xmlns:xs="http://www.w3.org/2001/XMLSchema"
           xmlns:glue="http://schemas.ogf.org/glue/2009/03/spec_2.0_r1"
           xmlns:ext="http://www.gocdbextensions.ac.uk/sample"
           xmlns="http://www.gocdbextensions.ac.uk/sample"
           targetNamespace="http://www.gocdbextensions.ac.uk/sample">

  <!-- This XSD imports the base glue2 XSD and extends AbstractService and
  AbstractEndpoint in order to derive custom Service and Endpoint types. -->
  <xs:import namespace="http://schemas.ogf.org/glue/2009/03/spec_2.0_r1"
             schemaLocation="glue2_2.xsd"/>

  <!-- For demonstration purposes, the MonitoredXEndpoint is defined as a
  child of the service so that the lifetime of the endpoint is strictly
  tied to its parent service.-->
  <xs:element name="MonitoredXService"
substitutionGroup="glue:AbstractService">
      <xs:complexType>
          <xs:complexContent>
              <xs:extension base="glue:ServiceBase_t">
                  <xs:sequence>
  <xs:element ref="ext:Monitored" minOccurs="1" maxOccurs="1"/>
  <xs:element ref="ext:Beta" minOccurs="1" maxOccurs="1"/>
  <xs:element ref="ext:MonitoredXEndpoint" minOccurs="1"
   maxOccurs="unbounded"/>
                  </xs:sequence>
              </xs:extension>
          </xs:complexContent>
      </xs:complexType>
  </xs:element>

  <xs:element name="Monitored" type="glue:ExtendedBoolean_t" />
  <xs:element name="Beta" type="glue:ExtendedBoolean_t" />

  <!-- MonitoredXEndpoint must be the same as, or be derived
  from AbstractEndpoint. It adds supplementary monitoring info. -->
  <xs:element name="MonitoredXEndpoint"
substitutionGroup="glue:AbstractEndpoint">
      <xs:complexType>
          <xs:complexContent>
              <xs:extension base="glue:EndpointBase_t">
                  <xs:sequence>
<xs:element ref="ext:DowntimeClassification" minOccurs="1" maxOccurs="1"/>
<xs:element ref="ext:DowntimeSeverity" minOccurs="1" maxOccurs="1"/>
                  </xs:sequence>
              </xs:extension>
          </xs:complexContent>
      </xs:complexType>
  </xs:element>

  <xs:element name="DowntimeClassification"
    type="ext:DowntimeClassification_t"/>
  <xs:element name="DowntimeSeverity" type="ext:DowntimeSeverity_t"/>
```

```
  <xs:simpleType name="DowntimeSeverity_t">
      <xs:restriction base="xs:string">
          <xs:enumeration value="OUTAGE"/>
          <xs:enumeration value="WARNING"/>
      </xs:restriction>
  </xs:simpleType>

  <xs:simpleType name="DowntimeClassification_t">
      <xs:restriction base="xs:string">
          <xs:enumeration value="SCHEDULED"/>
          <xs:enumeration value="UNSCHEDULED"/>
      </xs:restriction>
  </xs:simpleType>
</xs:schema>
```

Listing 12. Sample XML instance document that imports the both the GLUE 2 XSD and the sample XSD in Listing 11. In doing this, the custom `MonitoredXService` and `MonitoredXEndpoint` elements can be nested within `Entities`.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!--
The custom elements can be nested in the glue Entities element.
This requires no modification to the glue 2 xsd, but this doc must be
validated against both the base glue2 xsd and the extending xsd. -->
<Entities
    xmlns:xsi='http://www.w3.org/2001/XMLSchema-instance'
    xmlns:ext='http://www.gocdbextensions.ac.uk/sample'
    xmlns='http://schemas.ogf.org/glue/2009/03/spec_2.0_r1'
    xsi:schemaLocation='
    http://www.gocdbextensions.ac.uk/sample sampleGlue2_2Extension.xsd
    http://schemas.ogf.org/glue/2009/03/spec_2.0_r1 glue2_2.xsd'>

    <AdminDomain BaseType="Domain">
        <ID>124</ID>
        <Associations>
            <ServiceID>urn:mymonitoredXservice</ServiceID>
            <ServiceID>urn:mystandardService</ServiceID>
        </Associations>
    </AdminDomain>

    <Service BaseType="Service">
        <ID>urn:mystandardService</ID>
        <Type>NormalService</Type>
        <QualityLevel>production</QualityLevel>
        <Associations>
            <EndpointID>123</EndpointID>
        </Associations>
    </Service>

    <!--
    Our custom service type is substitutable for the AbstractService.
    We can therefore nest this type of service within Entities.
    This allows future glue profiles to define new services/endpoints
    without needing to modify the base GLUE 2 schema.
    -->
    <ext:MonitoredXService BaseType="Service">
        <ID>urn:mymonitoredXservice</ID>
        <Type>ServiceX</Type>
        <QualityLevel>production</QualityLevel>
        <ext:Monitored>true</ext:Monitored>
        <ext:Beta>true</ext:Beta>
        <ext:MonitoredXEndpoint BaseType="Endpoint">
            <ID>12</ID>
            <URL>adf</URL>
            <InterfaceName>adf</InterfaceName>
            <QualityLevel>development</QualityLevel>
            <HealthState>ok</HealthState>
            <ServingState>production</ServingState>
            <ext:DowntimeClassification>
            SCHEDULED
            </ext:DowntimeClassification>
            <ext:DowntimeSeverity>OUTAGE</ext:DowntimeSeverity>
        </ext:MonitoredXEndpoint>
    </ext:MonitoredXService>
```

```
    <Endpoint BaseType="Endpoint">
        <ID>123</ID>
        <URL>uri://some.url.ac.uk/service</URL>
        <InterfaceName></InterfaceName>
        <QualityLevel>development</QualityLevel>
        <HealthState>ok</HealthState>
        <ServingState>production</ServingState>
        <Associations>
            <ServiceID>urn:mystandardService</ServiceID>
        </Associations>
    </Endpoint>
</Entities>
```

3.8   Extensibility

In addition to substitution groups, the conceptual model defines two extra mechanisms for
extensions: the `Extension` class and the `OtherInfo` attribute (see Section 5.1 [glue-2]). In
the XML Schema mapping, the `Extension` class is mapped as a child of the `Extensions`
element. The `OtherInfo` attribute is mapped as an `OtherInfo` element. They are both
available in all entity elements for the purposes of extension.

The XML Schema also adds additional extension points using the `xsd:any` element at
specific locations within the document. Elements and attributes belonging to other
namespaces may be substituted in place of the `xsd:any` element (we use the `lax` value for
the `processContent` attribute of the `xsd:any` element and `##other` for the `namespace`
attribute). The `xsd:any` element is provided in the `Extensions`, `Extension` and `Entity`
elements. In the following example in Listing 13, we present a fragment showing how the
extensibility options can be used:

**Listing 13. Options for extension include the `OtherInfo, Extensions.Extension`
elements and the `xsd:any` extension element.**

```
<Entities...>
    ...
    <ExecutionEnvironment BaseType="Resource">
        <ID>executionEnvironment1</ID>
        <!-- Zero to many OtherInfo elements -->
        <OtherInfo>This is a powerful GPU system</OtherInfo>
        <OtherInfo>So is this one</OtherInfo>

        <!-- Extensions nests zero to many Extension elements -->
        <Extensions>
            <Extension>
                <LocalID>GeForge</LocalID>
                <Key>GeForge</Key>
                <Value>GeForge 7</Value>
            </Extension>

            <Extension>
                <LocalID>CoreLib</LocalID>
                <Key>CoreLib</Key>
                <Value>glibc:3.4.9</Value>
                <!-- xsd:any in Extension allows elements from other ns-->
                <typ:TextInfo xmlns:typ="http://unigrids.org/2006/04/types">
                    <typ:Name>StagingInPath</typ:Name>
                    <typ:Value>/user-home/in</typ:Value>
                </typ:TextInfo>
            </Extension>
```

```
            <!-- xsd:any within Extensions allows elements from other ns-->
            <typ:TextInfo xmlns:typ="http://unigrids.org/2006/04/types">
                <typ:Name>StagingInPath</typ:Name>
                <typ:Value>/user-home/in</typ:Value>
            </typ:TextInfo>
            <typ:TextInfo xmlns:typ="http://unigrids.org/2006/04/types">
                <typ:Name>StagingOutPath</typ:Name>
                <typ:Value>/user-home/out</typ:Value>
            </typ:TextInfo>
        </Extensions>
        ...
    </ExecutionEnvironment>
    ...
  <!-- xsd:any is last element in Entities allows elements from other ns-->
    <typ:TextInfo xmlns:typ="http://unigrids.org/2006/04/types">
        <typ:Name>StagingOutPath</typ:Name>
        <typ:Value>/user-home/out</typ:Value>
    </typ:TextInfo>
</Entities>
```

4. Security Considerations

Security considerations related to the GLUE information model are discussed in section 9 of the GLUE specification [glue-2]. Additional considerations apply to the use of XML – for those, see [rfc-3470].

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10. References

[glue-wg]   The GLUE Working Group of OGF,
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[glue-2]   GLUE Specification v. 2.0, OGF GFD.147, 3 Mar 2009,
             http://www.ogf.org/documents/GFD.147

[ogf-ns]   Standardised Namespaces for XML infosets in OGF.
             http://www.ogf.org/documents/GFD.84.pdf

[rfc-2119]   Key words for use in RFCs to Indicate Requirement Levels,
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 [rfc-3470] Guidelines for the Use of Extensible Markup Language (XML)
             within IETF Protocols,
             http://www.ietf.org/rfc/rfc3470.txt

[xsd-oe]   XForms 1.0. Open Enumeration,
             http://www.w3.org/TR/2002/WD-xforms-20020118/slice6.html
             #model-using-openenum

[xsd-ap]   Advanced XML Schema Patterns for Databinding Version 1.0,
             http://www.w3.org/TR/xmlschema-patterns-advanced/#group-Unions

11. The Normative XML Schema Realization of GLUE 2.0

XML examples, XSD, details also at: http://redmine.ogf.org/dmsf/glue-wg?folder_id=31

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!-- OGF GLUE 2.0 - XML Schema mapping


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    distributed under the License is distributed on an "AS IS" BASIS,
    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
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    limitations under the License.
-->
<?xml-stylesheet href="xs3p.xsl" type="text/xsl"?>
<schema targetNamespace="http://schemas.ogf.org/glue/2009/03/spec_2.0_r1"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:glue="http://schemas.ogf.org/glue/2009/03/spec_2.0_r1"
        xmlns:xhtml="http://www.w3.org/1999/xhtml"
        elementFormDefault="qualified"
        attributeFormDefault="unqualified">

    <!-- BEGIN DOCUMENT ROOT ELEMENT -->
    <element name="Entities" type="glue:ExtensibleEntities_t">
     <annotation>
        <documentation>
        <![CDATA[
        Entities is the Document Root element. It wraps an ordered list of
        GLUE2 Entity elements. Entity elements MAY derive from an abstract
        super-class element. Abstract elements cannot be directly created
        in an instance document and are designed to be implemented/extended
        by element specialisations. Specialisation elements must use the
        corresponding XSD substitutionGroup="abstract/head element name".
        As an example, the 'AbstractDomain' element can be substituted for
        either 'AdminDomain' or 'UserDomain.' Similary, 'AbstractService'
        can be substituted for 'ComputingService', 'StorageService' and
        'Service' elements.
        Extending profiles MAY define new element specialisations by
        defining the appropriate susbstition group AND deriving from the
        same base type as the abstract super-class. Specialisations can be
        nested within 'Entities' in place of the abstract/head elements.
        This requires no future modification of this XSD, but would require
        validation against both XSDs - this and the extending XSD. ]]>
        </documentation>
    </annotation>
```

```
        </element>
    <complexType name="ExtensibleEntities_t">
        <sequence>
            <element ref="glue:Location" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:Contact" minOccurs="0"
                    maxOccurs="unbounded"/>
            <!-- Abstract element references -->
            <element ref="glue:AbstractDomain" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:AbstractService" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:AbstractEndpoint" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:AbstractShare" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:AbstractManager" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:AbstractResource" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:AbstractActivity" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:AbstractPolicy" minOccurs="0"
                    maxOccurs="unbounded"/>
            <!-- Concrete element references -->
            <element ref="glue:Benchmark" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:ApplicationEnvironment" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:ToComputingService" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:ToStorageService" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:StorageAccessProtocol" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:StorageServiceCapacity" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:StorageShareCapacity" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element ref="glue:ApplicationHandle" minOccurs="0"
                    maxOccurs="unbounded"/>
            <xs:any namespace="##other" processContents="lax"
                    minOccurs="0" maxOccurs="unbounded"/>
        </sequence>
    </complexType>
    <!-- END DOCUMENT ROOT ELEMENT -->

    <!--  BEGIN MAIN ENTITY DECLARATIONS  -->
    <!--
    AbstractDomain and implementations
    ==================================
    -->
    <element name="AbstractDomain" type="glue:DomainBase_t"
            abstract="true"/>
    <element name="AdminDomain" type="glue:AdminDomain_t"
            substitutionGroup="glue:AbstractDomain"/>
    <element name="UserDomain" type="glue:UserDomain_t"
            substitutionGroup="glue:AbstractDomain"/>
    <!--
    AbstractService and implementations
    ==================================
    -->
    <element name="AbstractService" type="glue:ServiceBase_t"
            abstract="true"/>
    <element name="Service" type="glue:Service_t"
            substitutionGroup="glue:AbstractService"/>
    <element name="ComputingService" type="glue:ComputingService_t"
            substitutionGroup="glue:AbstractService"/>
```

```
    <element name="StorageService" type="glue:StorageService_t"
            substitutionGroup="glue:AbstractService"/>
<!--
AbstractEndpoint and implementations
====================================
-->
<element name="AbstractEndpoint" type="glue:EndpointBase_t"
        abstract="true"/>
<element name="Endpoint" type="glue:Endpoint_t"
        substitutionGroup="glue:AbstractEndpoint"/>
<element name="ComputingEndpoint" type="glue:ComputingEndpoint_t"
        substitutionGroup="glue:AbstractEndpoint"/>
<element name="StorageEndpoint" type="glue:StorageEndpoint_t"
        substitutionGroup="glue:AbstractEndpoint"/>
<!--
Abstract Share and implementations
===============================
-->
<element name="AbstractShare" type="glue:ShareBase_t"
        abstract="true"/>
<element name="ComputingShare" type="glue:ComputingShare_t"
        substitutionGroup="glue:AbstractShare"/>
<element name="StorageShare" type="glue:StorageShare_t"
        substitutionGroup="glue:AbstractShare"/>
<!--
Abstract Manager and implementations
================================
-->
<element name="AbstractManager" type="glue:ManagerBase_t"
        abstract="true"/>
<element name="StorageManager" type="glue:StorageManager_t"
        substitutionGroup="glue:AbstractManager"/>
<element name="ComputingManager" type="glue:ComputingManager t"
        substitutionGroup="glue:AbstractManager"/>
<!--
Abstract Resource and implementations
================================
-->
<element name="AbstractResource" type="glue:ResourceBase_t"
        abstract="true"/>
<element name="ExecutionEnvironment" type="glue:ExecutionEnvironment_t"
        substitutionGroup="glue:AbstractResource"/>
<element name="DataStore" type="glue:DataStore_t"
        substitutionGroup="glue:AbstractResource"/>
<!--
Activity and implementations
=================================
-->
<element name="AbstractActivity" type="glue:ActivityBase_t"
        abstract="true"/>
<element name="Activity" type="glue:Activity_t"
        substitutionGroup="glue:AbstractActivity"/>
<element name="ComputingActivity" type="glue:ComputingActivity_t"
        substitutionGroup="glue:AbstractActivity"/>
<!--
Abstract Policy and implementations
================================
-->
<element name="AbstractPolicy" type="glue:PolicyBase_t"
        abstract="true"/>
<element name="AccessPolicy" type="glue:AccessPolicy_t"
        substitutionGroup="glue:AbstractPolicy"/>
<element name="MappingPolicy" type="glue:MappingPolicy_t"
        substitutionGroup="glue:AbstractPolicy"/>
<!--
Concrete/Non-Substitutable Entities
================================
-->
```

```
    <element name="Location" type="glue:Location_t"/>
    <element name="Contact" type="glue:Contact_t"/>
    <element name="Benchmark" type="glue:Benchmark_t" />
    <element name="ApplicationEnvironment"
            type="glue:ApplicationEnvironment_t"/>
    <element name="ToComputingService" type="glue:ToComputingService_t"/>
    <element name="ToStorageService" type="glue:ToStorageService_t"/>
    <element name="StorageAccessProtocol"
            type="glue:StorageAccessProtocol_t"/>
    <element name="StorageServiceCapacity"
            type="glue:StorageServiceCapacity_t"/>
    <element name="StorageShareCapacity"
type="glue:StorageShareCapacity_t"/>
    <element name="ApplicationHandle" type="glue:ApplicationHandle_t"/>
    <!--  END MAIN ENTITY DECLARATIONS  -->

    <!--  BEGIN MAIN TYPE DECLARATIONS  -->
    <complexType name="Extension_t">
        <sequence>
            <element name="LocalID" type="glue:LocalID_t" minOccurs="1"
                    maxOccurs="1"/>
            <element name="Key" type="string" minOccurs="1" maxOccurs="1"/>
            <element name="Value" type="string" minOccurs="1"
maxOccurs="1"/>
            <xs:any namespace="##other" processContents="lax"
                    minOccurs="0" maxOccurs="unbounded"/>
        </sequence>
    </complexType>

    <complexType name="Extensions_t">
        <sequence>
            <element name="Extension" type="glue:Extension_t" minOccurs="0"
                    maxOccurs="unbounded"/>
            <xs:any namespace="##other" processContents="lax" minOccurs="0"
                    maxOccurs="unbounded"/>
        </sequence>
    </complexType>

    <complexType abstract="true" name="Entity_t">
        <sequence>
            <element name="ID" type="glue:ID_t" minOccurs="1"
maxOccurs="1"/>
            <element name="Name" type="string" minOccurs="0" maxOccurs="1"/>
            <element name="OtherInfo" type="string" minOccurs="0"
                    maxOccurs="unbounded"/>
            <element name="Extensions" type="glue:Extensions_t"
                    minOccurs="0" maxOccurs="1"/>
        </sequence>
        <attribute name="CreationTime" type="glue:DateTime_t"/>
        <attribute name="Validity" type="unsignedLong"/>
    </complexType>

    <complexType name="Location_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="Address" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="Place" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="Country" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="PostCode" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="Latitude" type="glue:Latitude_t"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="Longitude" type="glue:Longitude_t"
                            minOccurs="0" maxOccurs="1"/>
```

```
                        <element name="Associations" minOccurs="1"
maxOccurs="1">
                                <complexType>
                                    <sequence>
                                        <element name="ServiceID" type="glue:ID_t"
                                              minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[A Location is related to zero or more service implementations,
including Service, ComputingService and StorageService.]]>
                                                </documentation>
                                            </annotation>
                                        </element>
                                        <element name="DomainID" type="glue:ID_t"
                                              minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[A Location is related to zero or more domain implementations,
including AdminDomain and UserDomain.]]>
                                                </documentation>
                                            </annotation>
                                        </element>
                                    </sequence>
                                </complexType>
                            </element>
                        </sequence>
                    </extension>
                </complexContent>
            </complexType>

    <complexType name="Contact_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="Detail" type="anyURI" minOccurs="1"
                          maxOccurs="1"/>
                    <element name="Type" type="glue:ContactType_t"
                          minOccurs="1" maxOccurs="1"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ServiceID" type="glue:ID_t"
                                      minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A Contact is related to zero or more service implementations,
including Service, ComputingService and StorageService.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="DomainID" type="glue:ID_t"
                                      minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A Contact is related to zero or more domain implementations,
including AdminDomain and UserDomain.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
```

```
                    </extension>
                </complexContent>
            </complexType>

            <complexType abstract="true" name="DomainBase_t">
                <complexContent>
                    <extension base="glue:Entity_t">
                        <sequence>
                            <element name="Description" type="string"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="WWW" type="anyURI" minOccurs="0"
                                    maxOccurs="unbounded"/>
                        </sequence>
                        <attribute name="BaseType" fixed="Domain" use="required"/>
                    </extension>
                </complexContent>
            </complexType>

            <complexType name="AdminDomain_t">
                <complexContent>
                    <extension base="glue:DomainBase_t">
                        <sequence>
                            <element name="Distributed"
type="glue:ExtendedBoolean_t"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="Owner" type="string" minOccurs="0"
                                    maxOccurs="unbounded"/>
                            <element name="Associations" minOccurs="1"
maxOccurs="1">
                                <complexType>
                                    <sequence>
                                        <element name="ServiceID" type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[An AdminDomain manages zero or more service implementations
including Service, ComputingService and StorageService.]]>
                                                </documentation>
                                            </annotation>
                                        </element>
                                        <element name="ChildDomainID"
type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[An AdminDomain aggregates zero or more AdminDomains.]]>
                                                </documentation>

<appinfo>refType:AdminDomain</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="ParentDomainID"
type="glue:ID_t"
                                                minOccurs="0" maxOccurs="1">
                                            <annotation>
                                                <documentation>
<![CDATA[An AdminDomain can participate in another AdminDomain.]]>
                                                </documentation>

<appinfo>refType:AdminDomain</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="ContactID" type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded"/>
                                        <element name="LocationID" type="glue:ID_t"
```

```
                                              minOccurs="0" maxOccurs="1"/>
                                   </sequence>
                               </complexType>
                           </element>
                      </sequence>
                  </extension>
              </complexContent>
          </complexType>

      <complexType name="UserDomain_t">
          <complexContent>
              <extension base="glue:DomainBase_t">
                  <sequence>
                      <element name="Level" type="unsignedInt" minOccurs="0"
                               maxOccurs="1"/>
                      <element name="UserManager" type="anyURI" minOccurs="0"
                               maxOccurs="unbounded"/>
                      <element name="Member" type="string" minOccurs="0"
                               maxOccurs="unbounded"/>
                      <element name="Associations" minOccurs="1"
maxOccurs="1">
                          <complexType>
                              <sequence>
                                  <element name="PolicyID" type="glue:ID_t"
                                           minOccurs="0"
maxOccurs="unbounded">
                                      <annotation>
                                          <documentation>
<![CDATA[A UserDomain has zero or more policies, this includes
AccessPolicies
and MappingPolicies.]]>
                                          </documentation>

<appinfo>refType:AccessPolicy</appinfo>

<appinfo>refType:MappingPolicy</appinfo>
                                      </annotation>
                                  </element>
                                  <element name="ChildDomainID"
type="glue:ID_t"
                                           minOccurs="0"
maxOccurs="unbounded">
                                      <annotation>
                                          <documentation>
<![CDATA[A UserDomain aggregates zero or more User Domains.]]>
                                          </documentation>

<appinfo>refType:UserDomain</appinfo>
                                      </annotation>
                                  </element>
                                  <element name="ParentDomainID"
type="glue:ID_t"
                                           minOccurs="0" maxOccurs="1">
                                      <annotation>
                                          <documentation>
<![CDATA[A UserDomain participates in another User Domain.]]>
                                          </documentation>

<appinfo>refType:UserDomain</appinfo>
                                      </annotation>
                                  </element>
                                  <element name="ContactID" type="glue:ID_t"
                                           minOccurs="0"
maxOccurs="unbounded"/>
                                  <element name="LocationID" type="glue:ID_t"
                                           minOccurs="0" maxOccurs="1"/>
                              </sequence>
                          </complexType>
```

```
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType abstract="true" name="ServiceBase_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="Capability" type="glue:Capability_t"
                            minOccurs="0" maxOccurs="unbounded"/>
                    <element name="Type" type="glue:ServiceType_t"
                            minOccurs="1" maxOccurs="1"/>
                    <element name="QualityLevel" type="glue:QualityLevel_t"
                            minOccurs="1" maxOccurs="1"/>
                    <element name="StatusInfo" type="anyURI" minOccurs="0"
                            maxOccurs="unbounded"/>
                    <element name="Complexity" type="string" minOccurs="0"
                            maxOccurs="1"/>
                </sequence>
                <attribute name="BaseType" fixed="Service" use="required"/>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="Service_t">
        <complexContent>
            <extension base="glue:ServiceBase_t">
                <sequence>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="EndpointID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A service exposes zero or more Endpoints.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ShareID"
type="glue:LocalID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A Service offers zero or more Shares.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ManagerID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A Service offers zero or more Managers.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ContactID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded"/>
                                <element name="LocationID" type="glue:ID_t"
                                        minOccurs="0" maxOccurs="1"/>
                                <element name="ServiceID" type="glue:ID_t"
```

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                                                      minOccurs="0"
maxOccurs="unbounded">
                                              <annotation>
                                                  <documentation>
<![CDATA[A Service is related to zero or more other Services.]]>
                                                  </documentation>
                                              </annotation>
                                          </element>
                                      </sequence>
                                  </complexType>
                              </element>
                      </sequence>
                  </extension>
              </complexContent>
          </complexType>

      <complexType abstract="true" name="EndpointBase_t">
          <complexContent>
              <extension base="glue:Entity_t">
                  <sequence>
                      <element name="URL" type="anyURI" minOccurs="1"
                          maxOccurs="1"/>
                      <element name="Capability" type="glue:Capability_t"
                          minOccurs="0" maxOccurs="unbounded"/>
                      <element name="Technology"
type="glue:EndpointTechnology_t"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="InterfaceName"
type="glue:InterfaceName_t"
                          minOccurs="1" maxOccurs="1"/>
                      <element name="InterfaceVersion" type="string"
                          minOccurs="0" maxOccurs="unbounded"/>
                      <element name="InterfaceExtension" type="anyURI"
                          minOccurs="0" maxOccurs="unbounded"/>
                      <element name="WSDL" type="anyURI" minOccurs="0"
                          maxOccurs="unbounded"/>
                      <element name="SupportedProfile" type="anyURI"
                          minOccurs="0" maxOccurs="unbounded"/>
                      <element name="Semantics" type="anyURI" minOccurs="0"
                          maxOccurs="unbounded"/>
                      <element name="Implementor" type="string" minOccurs="0"
                          maxOccurs="1"/>
                      <element name="ImplementationName" type="string"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="ImplementationVersion" type="string"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="QualityLevel" type="glue:QualityLevel_t"
                          minOccurs="1" maxOccurs="1"/>
                      <element name="HealthState"
                          type="glue:EndpointHealthState_t"
                          minOccurs="1" maxOccurs="1"/>
                      <element name="HealthStateInfo" type="string"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="ServingState" type="glue:ServingState_t"
                          minOccurs="1" maxOccurs="1"/>
                      <element name="StartTime" type="glue:DateTime_t"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="IssuerCA" type="glue:DN_t" minOccurs="0"
                          maxOccurs="1"/>
                      <element name="TrustedCA" type="glue:DN_t" minOccurs="0"
                          maxOccurs="unbounded"/>
                      <element name="DowntimeAnnounce" type="glue:DateTime_t"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="DowntimeStart" type="glue:DateTime_t"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="DowntimeEnd" type="glue:DateTime_t"
                          minOccurs="0" maxOccurs="1"/>
                      <element name="DowntimeInfo" type="string"
```

```
                                  minOccurs="0" maxOccurs="1"/>
                </sequence>
                <attribute name="BaseType" fixed="Endpoint" use="required"/>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="Endpoint_t">
        <complexContent>
            <extension base="glue:EndpointBase_t">
                <sequence>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ServiceID" type="glue:ID t"
                                        minOccurs="1" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[An Endpoint is part of a Service.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ShareID"
type="glue:LocalID_t"
                                         minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[An Endpoint MAY pass activities to zero or more Shares.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="PolicyID" type="glue:ID_t"
                                         minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[An endpoint has associated zero or more AccessPolicies]]>
                                        </documentation>

<appinfo>refType:AccessPolicy</appinfo>
                                    </annotation>
                                </element>
                                <element name="ActivityID" type="glue:ID_t"
                                         minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[An Endpoint has accepted and is managing zero or more
Activities.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType abstract="true" name="ShareBase_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="Description" type="string"
                             minOccurs="0" maxOccurs="1"/>
```

```
                </sequence>
                <attribute name="BaseType" fixed="Share" use="required"/>
            </extension>
        </complexContent>
    </complexType>

    <complexType abstract="true" name="ManagerBase_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="ProductName"
                             type="glue:ComputingManagerType_t"/>
                    <element name="ProductVersion" type="string"
                             minOccurs="0"/>
                </sequence>
                <attribute name="BaseType" fixed="Manager" use="required"/>
            </extension>
        </complexContent>
    </complexType>

    <complexType abstract="true" name="ResourceBase_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence> </sequence>
                <attribute name="BaseType" fixed="Resource" use="required"/>
            </extension>
        </complexContent>
    </complexType>

    <complexType abstract="true" name="ActivityBase t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence> </sequence>
                <attribute name="BaseType" fixed="Activity" use="required"/>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="Activity_t">
        <complexContent>
            <extension base="glue:ActivityBase_t">
                <sequence>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="DomainID" type="glue:ID_t"
                                         minOccurs="0" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[An Activity is managed by a UserDomain.]]>
                                        </documentation>

<appinfo>refType:UserDomain</appinfo>
                                    </annotation>
                                </element>
                                <element name="EndpointID" type="glue:ID_t"
                                         minOccurs="0" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[An Activity is submitted to an Endpoint.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ShareID" type="glue:ID_t"
                                         minOccurs="0" maxOccurs="1">
                                    <annotation>
                                        <documentation>
```

```
<![CDATA[An Activity is mapped into a Share.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ResourceID" type="glue:ID_t"
                                        minOccurs="0" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[An Activity is executed in a resource.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ActivityID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[An Activity is related to zero or more other Activities.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType abstract="true" name="PolicyBase_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="Scheme" type="glue:PolicyScheme_t"
                            minOccurs="1" maxOccurs="1">
                        <annotation>
                            <documentation>
<![CDATA[The scheme used to define the syntax and semantics of the
policy rules.]]>
                            </documentation>
                        </annotation>
                    </element>
                    <element name="Rule" type="string"
                            minOccurs="1" maxOccurs="unbounded">
                        <annotation>
                            <documentation>
<![CDATA[A policy rule (for the basic poligy scheme).]]>
                            </documentation>
                        </annotation>
                    </element>
                </sequence>
                <attribute name="BaseType" fixed="Policy" use="required"/>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="AccessPolicy_t">
        <complexContent>
            <extension base="glue:PolicyBase_t">
                <sequence>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="EndpointID" type="glue:ID_t"
                                        minOccurs="1" maxOccurs="1">
                                    <annotation>
                                        <documentation>
```

```
<![CDATA[An AccessPolicy is related to an Endpoint.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="DomainID" type="glue:ID_t"
                                        minOccurs="1"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[An AccessPolicy is related to one or more UserDomains.]]>
                                        </documentation>

<appinfo>refType:UserDomain</appinfo>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="MappingPolicy_t">
        <complexContent>
            <extension base="glue:PolicyBase_t">
                <sequence>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ShareID" type="glue:ID_t"
                                        minOccurs="1" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[A MappingPolicy is related to a Share]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="DomainID" type="glue:ID_t"
                                        minOccurs="1"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A MappingPolicy is related to a UserDomain.]]>
                                        </documentation>

<appinfo>refType:UserDomain</appinfo>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!--  END MAIN ENTITY TYPE DECLARATIONS  -->


    <!--  BEGIN COMPUTING ENTITIES  -->
    <complexType name="ComputingService_t">
        <complexContent>
            <extension base="glue:ServiceBase_t">
                <sequence>
                    <element name="TotalJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="RunningJobs" type="unsignedInt"
```

```
                               minOccurs="0" maxOccurs="1"/>
                    <element name="WaitingJobs" type="unsignedInt"
                               minOccurs="0" maxOccurs="1"/>
                    <element name="StagingJobs" type="unsignedInt"
                               minOccurs="0" maxOccurs="1"/>
                    <element name="SuspendedJobs" type="unsignedInt"
                               minOccurs="0" maxOccurs="1"/>
                    <element name="PreLRMSWaitingJobs" type="unsignedInt"
                               minOccurs="0" maxOccurs="1"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="EndpointID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingService exposes zero or more ComputingEndpoints.]]>
                                        </documentation>

<appinfo>refType:ComputingEndpoint</appinfo>
                                    </annotation>
                                </element>
                                <element name="ShareID"
type="glue:LocalID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingService offers zero or more ComputingShares.]]>
                                        </documentation>

<appinfo>refType:ComputingShare</appinfo>
                                    </annotation>
                                </element>
                                <element name="ManagerID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingService offers zero or more ComputingManagers.]]>
                                        </documentation>

<appinfo>refType:ComputingManager</appinfo>
                                    </annotation>
                                </element>
                                <element name="ServiceID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingService can be associated with zero or more services,
including StorageServices.]]>
                                        </documentation>
                                    </annotation>
                                </element>
                                <element name="ContactID" type="glue:ID t"
                                        minOccurs="0"
maxOccurs="unbounded"/>
                                <element name="LocationID" type="glue:ID_t"
                                        minOccurs="0" maxOccurs="1"/>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
```

```
            </complexType>

    <complexType name="ComputingEndpoint_t">
        <complexContent>
            <extension base="glue:EndpointBase_t">
                <sequence>
                    <element name="Staging" type="glue:Staging_t"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="JobDescription"
type="glue:JobDescription_t"
                            minOccurs="0" maxOccurs="unbounded"/>
                    <element name="TotalJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="RunningJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="WaitingJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="StagingJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="SuspendedJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="PreLRMSWaitingJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ServiceID" type="glue:ID_t"
                                    minOccurs="1" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingEndpoint is part of a ComputingService.]]>
                                        </documentation>

<appinfo>refType:ComputingService</appinfo>
                                    </annotation>
                                </element>
                                <element name="ShareID" type="glue:ID_t"
                                    minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingEndpoint MAY pass activities to zero or more
ComputingShares.]]>
                                        </documentation>

<appinfo>refType:ComputingShare</appinfo>
                                    </annotation>
                                </element>
                                <element name="ActivityID" type="glue:ID_t"
                                    minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingEndpoint accepts and is managing zero or more
ComputingActivites.]]>
                                        </documentation>

<appinfo>refType:ComputingActivity</appinfo>
                                    </annotation>
                                </element>
                                <element name="PolicyID" type="glue:ID_t"
                                    minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingEndpoint has zero or more AccessPolicies.]]>
                                        </documentation>
```

```
                                              <appinfo>refType:AccessPolicy</appinfo>
                                          </annotation>
                                      </element>
                                  </sequence>
                              </complexType>
                          </element>
                      </sequence>
                  </extension>
              </complexContent>
        </complexType>

        <complexType name="ComputingShare_t">
            <complexContent>
                <extension base="glue:ShareBase_t">
                    <sequence>
                        <element name="MappingQueue" type="string" minOccurs="0"
                            maxOccurs="1"/>
                        <element name="MaxWallTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxMultiSlotWallTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MinWallTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="DefaultWallTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxCPUTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxTotalCPUTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MinCPUTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="DefaultCPUTime" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxTotalJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxRunningJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxWaitingJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxPreLRMSWaitingJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxUserRunningJobs" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxSlotsPerJob" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxStateInStreams" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxStageOutStreams" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="SchedulingPolicy"
                            type="glue:SchedulingPolicy_t" minOccurs="0"/>
                        <element name="MaxMainMemory" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="GuaranteedMainMemory" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="MaxVirtualMemory" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="GuaranteedVirtualMemory"
                            type="unsignedLong" minOccurs="0"
maxOccurs="1"/>
                        <element name="MaxDiskSpace" type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="DefaultStorageService" type="anyURI"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="Preemption" type="glue:ExtendedBoolean_t"
                            minOccurs="0" maxOccurs="1"/>
                        <element name="ServingState" type="glue:ServingState_t"
                            minOccurs="1" maxOccurs="1"/>
```

```
                            <element name="TotalJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="RunningJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="LocalRunningJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="WaitingJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="LocalWaitingJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="SuspendedJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="LocalSuspendedJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="StagingJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="PreLRMSWaitingJobs" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="EstimatedAverageWaitingTime"
                                    type="unsignedLong" minOccurs="0"
maxOccurs="1"/>
                            <element name="EstimatedWorstWaitingTime"
                                    type="unsignedLong" minOccurs="0"
maxOccurs="1"/>
                            <element name="FreeSlots" type="unsignedInt"
minOccurs="0"
                                    maxOccurs="1"/>
                            <element name="FreeSlotsWithDuration" type="string"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="UsedSlots" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="RequestedSlots"
                                    type="unsignedInt" minOccurs="0"
maxOccurs="1"/>
                            <element name="ReservationPolicy"
                                    type="glue:ReservationPolicy_t" minOccurs="0"
                                    maxOccurs="1"/>
                            <element name="Tag" type="string" minOccurs="0"
                                    maxOccurs="unbounded"/>
                            <element name="Associations" minOccurs="1"
maxOccurs="1">
                                <complexType>
                                    <sequence>
                                        <element name="EndpointID" type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[A ComputingShare MAY be consumed via one or more
ComputingEndpoints.]]>
                                                </documentation>

<appinfo>refType:ComputingEndpoint</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="ResourceID" type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[A ComputingShare is defiend on one or more
ExecutionEnvironments.]]>
                                                </documentation>

<appinfo>refType:ExecutionEnvironment</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="ServiceID" type="glue:ID_t"
```

```
                                                    minOccurs="1" maxOccurs="1">
                                        <annotation>
                                            <documentation>
<![CDATA[A ComputingShare participates in a ComputingService.]]>
                                            </documentation>

<appinfo>refType:ComputingService</appinfo>
                                        </annotation>
                                    </element>
                                    <element name="ActivityID" type="glue:ID_t"
                                            minOccurs="0"
maxOccurs="unbounded">
                                        <annotation>
                                            <documentation>
<![CDATA[A ComputingShare is being consumed by zero or more
ComputingActivities.]]>
                                            </documentation>

<appinfo>refType:ComputingActivity</appinfo>
                                        </annotation>
                                    </element>
                                    <element name="PolicyID" type="glue:ID_t"
                                            minOccurs="0"
maxOccurs="unbounded">
                                        <annotation>
                                            <documentation>
<![CDATA[A share has zero or more MappingPolicies.]]>
                                            </documentation>

<appinfo>refType:MappingPolicy</appinfo>
                                        </annotation>
                                    </element>
                                </sequence>
                            </complexType>
                        </element>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>

        <complexType name="ComputingManager_t">
            <complexContent>
                <extension base="glue:ManagerBase_t">
                    <sequence>
                        <element name="Reservation"
type="glue:ExtendedBoolean_t"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="BulkSubmission"
                                type="glue:ExtendedBoolean_t"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="TotalPhysicalCPUs" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="TotalLogicalCPUs" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="TotalSlots" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="SlotsUsedByLocalJobs" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="SlotsUsedByGridJobs" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="Homogeneous"
type="glue:ExtendedBoolean_t"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="NetworkInfo" type="glue:NetworkInfo_t"
                                minOccurs="0" maxOccurs="unbounded"/>
                        <element name="LogicalCPUDistribution" type="string"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="WorkingAreaShared"
```

```
                              type="glue:ExtendedBoolean_t"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="WorkingAreaGuaranteed"
                              type="glue:ExtendedBoolean_t"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="WorkingAreaTotal" type="unsignedLong"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="WorkingAreaFree" type="unsignedLong"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="WorkingAreaLifeTime"
                              type="unsignedLong" minOccurs="0"
maxOccurs="1"/>
                    <element name="WorkingAreaMultiSlotTotal"
                              type="unsignedLong" minOccurs="0"
maxOccurs="1"/>
                    <element name="WorkingAreaMultiSlotFree"
                              type="unsignedLong" minOccurs="0"
maxOccurs="1"/>
                    <element name="WorkingAreaMultiSlotLifeTime"
                              type="unsignedLong" minOccurs="0"
maxOccurs="1"/>
                    <element name="CacheTotal" type="unsignedLong"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="CacheFree" type="unsignedLong"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="TmpDir" type="string" minOccurs="0"
                              maxOccurs="1"/>
                    <element name="ScratchDir" type="string" minOccurs="0"
                              maxOccurs="1"/>
                    <element name="ApplicationDir" type="string"
minOccurs="0"
                              maxOccurs="1"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ServiceID" type="glue:ID_t"
                                     minOccurs="1" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingManager participates in a ComputingService.]]>
                                        </documentation>

<appinfo>refType:ComputingService</appinfo>
                                    </annotation>
                                </element>
                                <element name="ResourceID" type="glue:ID_t"
                                     minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingManager manages one or more ExecutionEnvironments.]]>
                                        </documentation>

<appinfo>refType:ExecutionEnvironment</appinfo>
                                    </annotation>
                                </element>
                                <element name="ApplicationEnvironmentID"
                                        type="glue:ID_t" minOccurs="0"
                                        maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingManager MAY use zero or more ApplicationEnvironments.]]>
                                        </documentation>

<appinfo>refType:ApplicationEnvironment</appinfo>
                                    </annotation>
                                </element>
```

```
                                <element name="BenchmarkID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A ComputingManager has zero or more associated Benchmarks.]]>
                                        </documentation>
                                        <appinfo>refType:Benchmark</appinfo>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="Benchmark_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="Type" type="glue:BenchmarkType_t"
                            minOccurs="1" maxOccurs="1"/>
                    <element name="Value" type="float" minOccurs="1"
                            maxOccurs="1"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ResourceID" type="glue:ID_t"
                                        minOccurs="0" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[A benchmark MAY be related to an ExecutionEnvironment.]]>
                                        </documentation>

<appinfo>refType:ExecutionEnvironment</appinfo>
                                    </annotation>
                                </element>
                                <element name="ManagerID" type="glue:ID_t"
                                        minOccurs="0" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[A benchmark MAY be related to a ComputingManager.]]>
                                        </documentation>

<appinfo>refType:ComputingManager</appinfo>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="ExecutionEnvironment_t">
        <complexContent>
            <extension base="glue:ResourceBase_t">
                <sequence>
                    <element name="Platform" type="glue:Platform_t"
                            minOccurs="1" maxOccurs="1"/>
                    <element name="VirtualMachine"
                            type="glue:ExtendedBoolean_t"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="TotalInstances" type="unsignedInt"
```

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                                        minOccurs="0" maxOccurs="1"/>
                        <element name="UsedInstances" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="UnavailableInstances" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="PhysicalCPUs" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="LogicalCPUs" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="CPUMultiplicity"
                                type="glue:CPUMultiplicity_t"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="CPUVendor" type="string" minOccurs="0"
                                maxOccurs="1"/>
                        <element name="CPUModel" type="string" minOccurs="0"
                                maxOccurs="1"/>
                        <element name="CPUVersion" type="string" minOccurs="0"
                                maxOccurs="1"/>
                        <element name="CPUClockSpeed" type="unsignedInt"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="CPUTimeScalingFactor" type="float"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="WallTimeScalingFactor" type="float"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="MainMemorySize" type="unsignedLong"
                                minOccurs="1" maxOccurs="1"/>
                        <element name="VirtualMemorySize" type="unsignedLong"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="OSFamily" type="glue:OSFamily_t"
                                minOccurs="1" maxOccurs="1"/>
                        <element name="OSName" type="glue:OSName_t"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="OSVersion" type="string"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="ConnectivityIn"
                                type="glue:ExtendedBoolean_t" minOccurs="1"
                                maxOccurs="1"/>
                        <element name="ConnectivityOut"
                                type="glue:ExtendedBoolean_t" minOccurs="1"
                                maxOccurs="1"/>
                        <element name="NetworkInfo" type="glue:NetworkInfo_t"
                                minOccurs="0" maxOccurs="unbounded"/>
                        <element name="Associations" minOccurs="1"
maxOccurs="1">
                            <complexType>
                                <sequence>
                                    <element name="ManagerID" type="glue:ID_t"
                                            minOccurs="1" maxOccurs="1">
                                        <annotation>
                                            <documentation>
<![CDATA[An ExecutionEnvironment is managed by a ComputingManager.]]>
                                            </documentation>

<appinfo>refType:ComputingManager</appinfo>
                                        </annotation>
                                    </element>
                                    <element name="ShareID" type="glue:ID_t"
                                            minOccurs="0"
maxOccurs="unbounded">
                                        <annotation>
                                            <documentation>
<![CDATA[An ExecutionEnvironment provides capacity in terms of
ComputingShares.]]>
                                            </documentation>

<appinfo>refType:ComputingShare</appinfo>
                                        </annotation>
                                    </element>
```

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                                        <element name="ActivityID" type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[An ExecutionEnvironment runs zeor or more ComputingActivities.]]>
                                                </documentation>

<appinfo>refType:ComputingActivity</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="ApplicationEnvironmentID"
                                                type="glue:ID_t" minOccurs="0"
                                                maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[An ExecutionEnvironment offers zero or more
ApplicationEnvironments.]]>
                                                </documentation>

<appinfo>refType:ApplicationEnvironment</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="BenchmarkID" type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[An ExecutionEnvironment has zero or more associated Benchmarks.]]>
                                                </documentation>
                                                <appinfo>refType:Benchmark</appinfo>
                                            </annotation>
                                        </element>
                                    </sequence>
                                </complexType>
                            </element>
                        </sequence>
                    </extension>
                </complexContent>
            </complexType>

            <complexType name="ApplicationEnvironment_t">
                <complexContent>
                    <extension base="glue:Entity_t">
                        <sequence>
                            <element name="AppName" type="string"
                                    minOccurs="1" maxOccurs="1"/>
                            <element name="AppVersion" type="string"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="Repository" type="anyURI"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="State" type="glue:AppEnvState_t"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="RemovalDate" type="glue:DateTime_t"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="License" type="glue:License_t"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="Description" type="string"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="BestBenchmark"
                                    type="glue:BenchmarkType_t" minOccurs="0"
                                    maxOccurs="unbounded"/>
                            <element name="ParallelSupport"
                                    type="glue:ParallelSupport_t" minOccurs="0"
                                    maxOccurs="1"/>
                            <element name="MaxSlots" type="unsignedInt"
                                    minOccurs="0" maxOccurs="1"/>
                            <element name="MaxJobs" type="unsignedInt"
```

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                              minOccurs="0" maxOccurs="1"/>
                    <element name="MaxUserSeats" type="unsignedInt"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="FreeSlots" type="unsignedInt"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="FreeJobs" type="unsignedInt"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="FreeUserSeats" type="unsignedInt"
                              minOccurs="0" maxOccurs="1"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ResourceID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[An ApplicationEnvironment MAY be used in zero or more
ExecutionEnvironments.]]>
                                        </documentation>

<appinfo>refType:ExecutionEnvironment</appinfo>
                                    </annotation>
                                </element>
                                <element name="ManagerID" type="glue:ID_t"
                                        minOccurs="1" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[An ApplicationEnvironment is part of a ComputingManager.]]>
                                        </documentation>

<appinfo>refType:ComputingManager</appinfo>
                                    </annotation>
                                </element>
                                <element name="ApplicationHandleID"
                                        type="glue:ID_t" minOccurs="0"
                                        maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[An ApplicationEnvironment MAY be handled via zero or
more ApplicationHandles.]]>
                                        </documentation>

<appinfo>refType:ApplicationHandle</appinfo>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="ApplicationHandle_t">
        <complexContent>
            <extension base="glue:Entity_t">
                <sequence>
                    <element name="Type" type="glue:ApplicationHandleType_t"
                              minOccurs="1" maxOccurs="1"/>
                    <element name="Value" type="string" minOccurs="1"
                              maxOccurs="1"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="ApplicationEnvironmentID"
```

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                                                    type="glue:ID_t" minOccurs="1"
                                                    maxOccurs="1">
                                            <annotation>
                                                <documentation>
<![CDATA[An ApplicationHandle should be used for one app environment.]]>
                                                </documentation>

<appinfo>refType:ApplicationEnvironment</appinfo>
                                            </annotation>
                                        </element>
                                </sequence>
                            </complexType>
                        </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>

    <complexType name="ComputingActivity_t">
        <complexContent>
            <extension base="glue:ActivityBase_t">
                <sequence>
                    <element name="Type" type="glue:ComputingActivityType_t"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="IDFromEndpoint" type="anyURI"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="LocalIDFromManager" type="string"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="JobDescription"
type="glue:JobDescription_t"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="State"
type="glue:ComputingActivityState_t"
                            minOccurs="1" maxOccurs="unbounded"/>
                    <element name="RestartState"
                            type="glue:ComputingActivityState_t"
minOccurs="0"
                            maxOccurs="unbounded"/>
                    <element name="ExitCode" type="int" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="ComputingManagerExitCode" type="string"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="Error" type="string" minOccurs="0"
                            maxOccurs="unbounded"/>
                    <element name="WaitingPosition" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="UserDomain" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="Owner" type="string" minOccurs="1"
                            maxOccurs="1"/>
                    <element name="LocalOwner" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="RequestedTotalWallTime"
type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="RequestedTotalCPUTime"
type="unsignedLong"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="RequestedSlots" type="unsignedInt"
                            minOccurs="0" maxOccurs="1"/>
                    <element name="RequestedApplicationEnvironment"
                            type="string" minOccurs="0"
                            maxOccurs="unbounded"/>
                    <element name="StdIn" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="StdOut" type="string" minOccurs="0"
                            maxOccurs="1"/>
                    <element name="StdErr" type="string" minOccurs="0"
```

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                               maxOccurs="1"/>
                 <element name="LogDir" type="string" minOccurs="0"
                        maxOccurs="1"/>
                 <element name="ExecutionNode" type="string"
minOccurs="0"
                        maxOccurs="unbounded"/>
                 <element name="Queue" type="string" minOccurs="0"
                        maxOccurs="1"/>
                 <element name="UsedTotalWallTime" type="unsignedLong"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="UsedTotalCPUTime" type="unsignedLong"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="UsedMainMemory" type="unsignedLong"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="SubmissionTime" type="glue:DateTime_t"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="ComputingManagerSubmissionTime"
                        type="glue:DateTime_t" minOccurs="0"
                        maxOccurs="1"/>
                 <element name="StartTime" type="glue:DateTime_t"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="ComputingManagerEndTime"
                        type="glue:DateTime_t" minOccurs="0"
                        maxOccurs="1"/>
                 <element name="EndTime" type="glue:DateTime_t"
                        minOccurs="0"
                        maxOccurs="1"/>
                 <element name="WorkingAreaEraseTime"
type="glue:DateTime_t"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="ProxyExpirationTime"
type="glue:DateTime_t"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="SubmissionHost" type="string"
minOccurs="0"
                        maxOccurs="1"/>
                 <element name="SubmissionClientName" type="string"
                        minOccurs="0" maxOccurs="1"/>
                 <element name="OtherMessages" type="string"
minOccurs="0"
                        maxOccurs="unbounded"/>
                 <element name="Associations" minOccurs="1"
maxOccurs="1">
                     <complexType>
                        <sequence>
                            <element name="EndpointID" type="glue:ID_t"
                                   minOccurs="0" maxOccurs="1">
                                <annotation>
                                   <documentation>
<![CDATA[A ComputingActivity is submitted to a ComputingEndpoint.]]>
                                   </documentation>

<appinfo>refType:ComputingEndpoint</appinfo>
                                </annotation>
                            </element>
                            <element name="ShareID" type="glue:ID_t"
                                   minOccurs="0" maxOccurs="1">
                                <annotation>
                                   <documentation>
<![CDATA[A ComputingActivity is mapped into a ComputingShare.]]>
                                   </documentation>

<appinfo>refType:ComputingShare</appinfo>
                                </annotation>
                            </element>
                            <element name="ResourceID" type="glue:ID_t"
                                   minOccurs="0" maxOccurs="1">
                                <annotation>
```

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                                                <documentation>
<![CDATA[A ComputingActivity is executed in an ExecutionEnvironment.]]>
                                                </documentation>

<appinfo>refType:ExecutionEnvironment</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="DomainID" type="glue:ID_t"
                                                minOccurs="0" maxOccurs="1">
                                            <annotation>
                                                <documentation>
<![CDATA[A ComputingActivity is managed by a UserDomain.]]>
                                                </documentation>

<appinfo>refType:UserDomain</appinfo>
                                            </annotation>
                                        </element>
                                        <element name="ActivityID" type="glue:ID_t"
                                                minOccurs="0"
maxOccurs="unbounded">
                                            <annotation>
                                                <documentation>
<![CDATA[An activity is related to zero or more activities.]]>
                                                </documentation>
                                            </annotation>
                                        </element>
                                    </sequence>
                                </complexType>
                            </element>
                        </sequence>
                    </extension>
                </complexContent>
            </complexType>

            <complexType name="ToStorageService_t">
                <complexContent>
                    <extension base="glue:Entity_t">
                        <sequence>
                            <element name="LocalPath" type="string" minOccurs="1"
                                    maxOccurs="1"/>
                            <element name="RemotePath" type="string" minOccurs="1"
                                    maxOccurs="1"/>
                            <element name="Associations" minOccurs="1"
maxOccurs="1">
                                <complexType>
                                    <sequence>
                                        <element name="ServiceID" type="glue:ID_t"
                                                minOccurs="2" maxOccurs="2">
                                            <annotation>
                                                <documentation>
<![CDATA[A ToStorageService is associated to one ComputingService
and one StorageService.]]>
                                                </documentation>

<appinfo>refType:ComputingService</appinfo>
                                                <appinfo>refType:StorageService</appinfo>
                                            </annotation>
                                        </element>
                                    </sequence>
                                </complexType>
                            </element>
                        </sequence>
                    </extension>
                </complexContent>
            </complexType>
            <!--  END COMPUTING ENTITIES  -->

            <!--  BEGIN STORAGE ENTITIES  -->
```

```
    <complexType name="StorageService_t">
        <complexContent>
            <extension base="glue:ServiceBase_t">
                <sequence>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="EndpointID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageService exposes zero or more StorageEndpoints.]]>
                                        </documentation>

<appinfo>refType:StorageEndpoint</appinfo>
                                    </annotation>
                                </element>
                                <element name="ShareID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageService serves zero or more StorageShares.]]>
                                        </documentation>

<appinfo>refType:StorageShare</appinfo>
                                    </annotation>
                                </element>
                                <element name="ManagerID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageService provides zero or more StorageManagers.]]>
                                        </documentation>

<appinfo>refType:StorageManager</appinfo>
                                    </annotation>
                                </element>
                                <element name="StorageAccessProtocolID"
                                        type="glue:ID_t" minOccurs="0"
                                        maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageService offers zero or more StorageAccessProtocols.]]>
                                        </documentation>

<appinfo>refType:StorageAccessProtocol</appinfo>
                                    </annotation>
                                </element>
                                <element name="StorageServiceCapacityID"
                                        type="glue:ID_t" minOccurs="0"
                                        maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageService has zero or more StorageServiceCapacities.]]>
                                        </documentation>

<appinfo>refType:StorageServiceCapacity</appinfo>
                                    </annotation>
                                </element>
                                <element name="ContactID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded"/>
                                <element name="LocationID" type="glue:ID_t"
                                        minOccurs="0" maxOccurs="1"/>
```

```
                                    <element name="ServiceID" type="glue:ID_t"
                                            minOccurs="0"
maxOccurs="unbounded"/>
                            </sequence>
                        </complexType>
                    </element>
            </sequence>
        </extension>
    </complexContent>
</complexType>


<complexType name="StorageServiceCapacity_t">
    <complexContent>
        <extension base="glue:Entity_t">
            <sequence>
                <element name="Type" type="glue:StorageCapacity_t"/>
                <element name="TotalSize" type="unsignedLong"
                        minOccurs="0"/>
                <element name="FreeSize" type="unsignedLong"
                        minOccurs="0"/>
                <element name="UsedSize" type="unsignedLong"
                        minOccurs="0"/>
                <element name="ReservedSize" type="unsignedLong"
                        minOccurs="0"/>
                <element name="Associations" minOccurs="1"
maxOccurs="1">
                    <complexType>
                        <sequence>
                            <element name="ServiceID" type="glue:ID t"
                                    minOccurs="1" maxOccurs="1">
                                <annotation>
                                    <documentation>
<![CDATA[A StorageServiceCapacity is related to one StorageService.]]>
                                    </documentation>

<appinfo>refType:StorageService</appinfo>
                                </annotation>
                            </element>
                        </sequence>
                    </complexType>
                </element>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="StorageAccessProtocol_t">
    <sequence>
        <element name="Type" type="glue:StorageAccessProtocolType_t"/>
        <element name="Version" type="string"/>
        <element name="MaxStreams" type="int" minOccurs="0"/>
        <element name="Associations" minOccurs="1" maxOccurs="1">
            <complexType>
                <sequence>
                    <element name="ServiceID" type="glue:ID_t"
                            minOccurs="1" maxOccurs="1">
                        <annotation>
                            <documentation>
<![CDATA[A StorageAccessProtocol is related to one StorageService.]]>
                            </documentation>
                            <appinfo>refType:StorageService</appinfo>
                        </annotation>
                    </element>
                    <element name="ToComputingServiceID"
type="glue:ID_t"
                            minOccurs="0" maxOccurs="unbounded">
                        <annotation>
```

```
                                        <documentation><![CDATA[A
StorageAccessProtocol
MAY be used by zero or more ComputingServices.]]>
                                        </documentation>

<appinfo>refType:ToComputingService</appinfo>
                                    </annotation>
                                </element>
                            </sequence>
                        </complexType>
                    </element>
                </sequence>
        </complexType>

        <complexType name="StorageEndpoint_t">
            <complexContent>
                <extension base="glue:EndpointBase_t">
                    <sequence>
                        <element name="Associations" minOccurs="1"
maxOccurs="1">
                            <complexType>
                                <sequence>
                                    <element name="ServiceID" type="glue:ID_t"
                                        minOccurs="1" maxOccurs="1">
                                        <annotation>
                                            <documentation>
<![CDATA[A StorageEndpoint is part of a StorageService.]]>
                                            </documentation>
                                            <appinfo>refType:StorageService</appinfo>
                                        </annotation>
                                    </element>
                                    <element name="ShareID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                        <annotation>
                                            <documentation><![CDATA[A
StorageShare
MAY pass activities to zero or more StorageShares.]]>
                                            </documentation>
                                         <appinfo>refType:StorageShare</appinfo>
                                        </annotation>
                                    </element>
                                    <element name="PolicyID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                        <annotation>
                                            <documentation>
<![CDATA[A StorageEndpoint has zero or more AccessPolicies.]]>
                                            </documentation>

<appinfo>refType:AccessPolicy</appinfo>
                                    </annotation>
                                    </element>
                                </sequence>
                            </complexType>
                        </element>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>

        <complexType name="StorageShare_t">
            <complexContent>
                <extension base="glue:ShareBase_t">
                    <sequence>
                        <element name="ServingState" type="glue:ServingState_t"
                            minOccurs="1" />
                        <element name="Path" type="string" minOccurs="0"/>
```

```
                    <element name="AccessMode" type="glue:AccessMode_t"
                            minOccurs="0" maxOccurs="unbounded"/>
                    <element name="SharingID" type="glue:LocalID_t"
                            minOccurs="1"/>
                    <element name="AccessLatency"
type="glue:AccessLatency_t"
                            minOccurs="1"/>
                    <element name="RetentionPolicy"
                            type="glue:RetentionPolicy_t" minOccurs="0"
                            maxOccurs="unbounded"/>
                    <element name="ExpirationMode"
type="glue:ExpirationMode_t"
                            minOccurs="0" maxOccurs="3"/>
                    <element name="DefaultLifeTime" type="int"
minOccurs="0"/>
                    <element name="MaximumLifeTime" type="int"
minOccurs="0"/>
                    <element name="Tag" type="string" minOccurs="0"/>
                    <element name="Associations" minOccurs="1"
maxOccurs="1">
                        <complexType>
                            <sequence>
                                <element name="EndpointID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageShare is consumed by zero or more StorageEndpoints.]]>
                                        </documentation>

<appinfo>refType:StorageEndpoint</appinfo>
                                    </annotation>
                                </element>
                                <element name="ResourceID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageShare is defined on zero or more DataStores.]]>
                                        </documentation>
                                        <appinfo>refType:DataStore</appinfo>
                                    </annotation>
                                </element>
                                <element name="ServiceID" type="glue:ID_t"
                                        minOccurs="1" maxOccurs="1">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageShare participates in a StorageService.]]>
                                        </documentation>

<appinfo>refType:StorageService</appinfo>
                                    </annotation>
                                </element>
                                <element name="StorageShareCapacityID"
                                        type="glue:ID_t" minOccurs="0"
                                        maxOccurs="unbounded">
                                    <annotation>
                                        <documentation>
<![CDATA[A StorageShare offers zero or more share capacities.]]>
                                        </documentation>

<appinfo>refType:StorageShareCapacity</appinfo>
                                    </annotation>
                                </element>
                                <element name="PolicyID" type="glue:ID_t"
                                        minOccurs="0"
maxOccurs="unbounded">
                                    <annotation>
```

```
                                                 <documentation>
<![CDATA[A StorageShare has zero or more MappingPolicies.]]>
                                                 </documentation>

<appinfo>refType:MappingPolicy</appinfo>
                                             </annotation>
                                         </element>
                                     </sequence>
                                 </complexType>
                             </element>
                     </sequence>
                 </extension>
             </complexContent>
     </complexType>

     <complexType name="StorageShareCapacity t">
         <complexContent>
             <extension base="glue:Entity t">
                 <sequence>
                     <element name="Type" type="glue:StorageCapacity_t"/>
                     <element name="TotalSize" type="int" minOccurs="0"/>
                     <element name="FreeSize" type="int" minOccurs="0"/>
                     <element name="UsedSize" type="int" minOccurs="0"/>
                     <element name="ReservedSize" type="int" minOccurs="0"/>
                     <element name="Associations" minOccurs="1"
maxOccurs="1">
                         <complexType>
                             <sequence>
                                 <element name="ShareID" type="glue:ID_t"
                                       minOccurs="1" maxOccurs="1">
                                     <annotation>
                                         <documentation>
<![CDATA[A StorageShareCapacity is related to one StorageShare.]]>
                                         </documentation>

<appinfo>refType:StorageShare</appinfo>
                                     </annotation>
                                 </element>
                             </sequence>
                         </complexType>
                     </element>
                 </sequence>
             </extension>
         </complexContent>
     </complexType>

     <complexType name="StorageManager_t">
         <complexContent>
             <extension base="glue:ManagerBase_t">
                 <sequence>
                     <element name="Associations" minOccurs="1"
maxOccurs="1">
                         <complexType>
                             <sequence>
                                 <element name="ServiceID" type="glue:ID_t"
                                       minOccurs="1" maxOccurs="1">
                                     <annotation>
                                         <documentation>
<![CDATA[A StorageManager participates in a StorageService.]]>
                                         </documentation>

<appinfo>refType:StorageService</appinfo>
                                     </annotation>
                                 </element>
                                 <element name="ResourceID" type="glue:ID_t"
                                       minOccurs="0"
maxOccurs="unbounded">
                                     <annotation>
```

```
                                              <documentation>
<![CDATA[A StorageManager manages zero or more DataStores.]]>
                                              </documentation>
                                              <appinfo>refType:DataStore</appinfo>
                                          </annotation>
                                      </element>
                                  </sequence>
                              </complexType>
                          </element>
                  </sequence>
              </extension>
          </complexContent>
      </complexType>

      <complexType name="DataStore_t">
          <complexContent>
              <extension base="glue:ResourceBase_t">
                  <sequence>
                      <element name="Type" type="glue:DataStoreType_t"/>
                      <element name="Latency" type="glue:AccessLatency_t"/>
                      <element name="TotalSize" type="int" minOccurs="0"/>
                      <element name="FreeSize" type="int" minOccurs="0"/>
                      <element name="UsedSize" type="int" minOccurs="0"/>
                      <element name="Associations" minOccurs="1"
maxOccurs="1">
                          <complexType>
                              <sequence>
                                  <element name="ManagerID" type="glue:ID_t"
                                      minOccurs="1" maxOccurs="1">
                                      <annotation>
                                          <documentation>
<![CDATA[A DataStore is managed by a StorageManager.]]>
                                          </documentation>

<appinfo>refType:StorageManager</appinfo>
                                      </annotation>
                                  </element>
                                  <element name="ShareID" type="glue:ID_t"
                                      minOccurs="0"
maxOccurs="unbounded">
                                      <annotation>
                                          <documentation>
<![CDATA[A DataStore provides capacity in terms of zero or more
StorageShares.]]>
                                          </documentation>

<appinfo>refType:StorageShare</appinfo>
                                      </annotation>
                                  </element>
                              </sequence>
                          </complexType>
                      </element>
                  </sequence>
              </extension>
          </complexContent>
      </complexType>

      <complexType name="ToComputingService_t">
          <complexContent>
              <extension base="glue:Entity_t">
                  <sequence>
                      <element name="NetworkInfo" type="glue:NetworkInfo_t"
                          minOccurs="0"/>
                      <element name="Bandwidth" type="int" minOccurs="0"/>
                      <element name="Associations" minOccurs="1">
                          <complexType>
                              <sequence>
                                  <element name="StorageAccessProtocolID"
```

```
                                               type="glue:ID_t" minOccurs="0"
                                               maxOccurs="unbounded">
                                      <annotation>
                                          <documentation>
<![CDATA[The StorageService MAY be accessed via an access protocol by a
certain
computing service.]]>
                                          </documentation>

<appinfo>refType:StorageAccessProtocol</appinfo>
                                      </annotation>
                                  </element>
                                  <element name="ServiceID" type="glue:ID_t"
                                           minOccurs="2" maxOccurs="2">
                                      <annotation>
                                          <documentation>
<![CDATA[ToComputingService is associated to one ComputingService and one
StorageService.]]>
                                          </documentation>

<appinfo>refType:ComputingService</appinfo>

<appinfo>refType:StorageService</appinfo>
                                      </annotation>
                                  </element>
                              </sequence>
                          </complexType>
                      </element>
                  </sequence>
              </extension>
          </complexContent>
      </complexType>
      <!--  END STORAGE ENTITIES  -->

      <!-- BEGIN DATA TYPES -->
      <simpleType name="AccessLatency_t">
          <restriction base="string">
              <enumeration value="online"/>
              <enumeration value="nearline"/>
              <enumeration value="offline"/>
          </restriction>
      </simpleType>

      <simpleType name="AccessMode_t">
          <restriction base="string"/>
      </simpleType>

      <simpleType name="AppEnvState_t">
          <union memberTypes="string">
              <simpleType>
                  <restriction base="string">
                      <enumeration value="installable"/>
                      <enumeration value="installationfailed"/>
                      <enumeration value="installedbroken"/>
                      <enumeration value="installednotverified"/>
                      <enumeration value="installedverified"/>
                      <enumeration value="installingautomatically"/>
                      <enumeration value="installingmanually"/>
                      <enumeration value="notinstallable"/>
                      <enumeration value="pendingremoval"/>
                      <enumeration value="removing"/>
                  </restriction>
              </simpleType>
          </union>
      </simpleType>

      <simpleType name="ApplicationHandleType_t">
          <union memberTypes="string">
```

```
            <simpleType>
                <restriction base="string">
                    <enumeration value="module"/>
                    <enumeration value="softenv"/>
                    <enumeration value="path"/>
                    <enumeration value="executable"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="BenchmarkType_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="bogomips"/>
                    <enumeration value="cfp2006"/>
                    <enumeration value="cint2006"/>
                    <enumeration value="linpack"/>
                    <enumeration value="specfp2000"/>
                    <enumeration value="specint2000"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="Capability_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="data.access.flatfiles"/>
                    <enumeration value="data.access.relational"/>
                    <enumeration value="data.access.xml"/>
                    <enumeration value="data.management.replica"/>
                    <enumeration value="data.management.storage"/>
                    <enumeration value="data.management.transfer"/>
                    <enumeration value="data.naming.resolver"/>
                    <enumeration value="data.naming.scheme"/>
                    <enumeration value="data.transfer"/>
                    <enumeration
                        value="executionmanagement.candidatesetgenerator"/>
                    <enumeration
value="executionmanagement.dynamicvmdeploy"/>
                    <enumeration
                        value="executionmanagement.executionandplanning"/>
                    <enumeration
value="executionmanagement.jobdescription"/>
                    <enumeration value="executionmanagement.jobexecution"/>
                    <enumeration value="executionmanagement.jobmanager"/>
                    <enumeration value="executionmanagement.reservation"/>
                    <enumeration value="information.discovery"/>
                    <enumeration value="information.logging"/>
                    <enumeration value="information.model"/>
                    <enumeration value="information.monitoring"/>
                    <enumeration value="information.provenance"/>
                    <enumeration value="security.accounting"/>
                    <enumeration value="security.attributeauthority"/>
                    <enumeration value="security.authentication"/>
                    <enumeration value="security.authorization"/>
                    <enumeration value="security.credentialstorage"/>
                    <enumeration value="security.delegation"/>
                    <enumeration value="security.identymapping"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="ComputingActivityState_t">
```

```xml
                    <union memberTypes="string">
                        <simpleType>
                            <restriction base="string">
                                <enumeration value="bes:failed"/>
                                <enumeration value="bes:finished"/>
                                <enumeration value="bes:pending"/>
                                <enumeration value="bes:running"/>
                                <enumeration value="bes:terminated"/>
                                <enumeration value="unicore:undefined"/>
                                <enumeration value="unicore:ready"/>
                                <enumeration value="unicore:queued"/>
                                <enumeration value="unicore:running"/>
                                <enumeration value="unicore:successful"/>
                                <enumeration value="unicore:failed"/>
                                <enumeration value="unicore:stagingin"/>
                                <enumeration value="unicore:stagingout"/>
                                <enumeration value="nordugrid:accepting"/>
                                <enumeration value="nordugrid:pending:accepted"/>
                                <enumeration value="nordugrid:accepted"/>
                                <enumeration value="nordugrid:pending:preparing"/>
                                <enumeration value="nordugrid:preparing"/>
                                <enumeration value="nordugrid:prepared"/>
                                <enumeration value="nordugrid:submitting"/>
                                <enumeration value="nordugrid:pending:inlrms"/>
                                <enumeration value="nordugrid:inlrms:q"/>
                                <enumeration value="nordugrid:inlrms:h"/>
                                <enumeration value="nordugrid:inlrms:r"/>
                                <enumeration value="nordugrid:inlrms:s"/>
                                <enumeration value="nordugrid:inlrms:e"/>
                                <enumeration value="nordugrid:inlrms:o"/>
                                <enumeration value="nordugrid:inlrms:executed"/>
                                <enumeration value="nordugrid:finishing"/>
                                <enumeration value="nordugrid:canceling"/>
                                <enumeration value="nordugrid:failed"/>
                                <enumeration value="nordugrid:killed"/>
                                <enumeration value="nordugrid:finished"/>
                                <enumeration value="nordugrid:deleted"/>
                            </restriction>
                        </simpleType>
                    </union>
    </simpleType>

    <simpleType name="ComputingActivityType_t">
        <restriction base="string">
            <enumeration value="collectionelement"/>
            <enumeration value="parallelelement"/>
            <enumeration value="single"/>
            <enumeration value="workflownode"/>
        </restriction>
    </simpleType>

    <simpleType name="ComputingManagerType_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="bqs"/>
                    <enumeration value="condor"/>
                    <enumeration value="fork"/>
                    <enumeration value="loadleveler"/>
                    <enumeration value="lsf"/>
                    <enumeration value="openbps"/>
                    <enumeration value="gridengine"/>
                    <enumeration value="torque"/>
                    <enumeration value="torquemaui"/>
                    <enumeration value="slurm"/>
                </restriction>
            </simpleType>
        </union>
```

```xml
        </simpleType>

        <simpleType name="ContactType_t">
            <union memberTypes="string">
                <simpleType>
                    <restriction base="string">
                        <enumeration value="general"/>
                        <enumeration value="security"/>
                        <enumeration value="sysadmin"/>
                        <enumeration value="usersupport"/>
                    </restriction>
                </simpleType>
            </union>
        </simpleType>

        <simpleType name="CPUMultiplicity_t">
            <restriction base="string">
                <enumeration value="multicpu-multicore"/>
                <enumeration value="multicpu-singlecore"/>
                <enumeration value="singlecpu-multicore"/>
                <enumeration value="singlecpu-singlecore"/>
            </restriction>
        </simpleType>

        <simpleType name="DataStoreType_t">
            <union memberTypes="string">
                <simpleType>
                    <restriction base="string">
                        <enumeration value="disk"/>
                        <enumeration value="optical"/>
                        <enumeration value="tape"/>
                    </restriction>
                </simpleType>
            </union>
        </simpleType>

        <simpleType name="DateTime_t">
            <restriction base="dateTime">
                <annotation>
                    <documentation><![CDATA[
                    For interoperability, the pattern of the dateTime
                    is not restricted to the following pattern:
                    "\d{4}-\d\d-\d\dT\d\d:\d\d:\d\dZ"
                    ]]>
                    </documentation>
                </annotation>
                <!--<pattern value="\d{4}-\d\d-\d\dT\d\d:\d\d:\d\dZ"/>-->
            </restriction>
        </simpleType>

        <simpleType name="DN_t">
            <restriction base="string"/>
        </simpleType>

        <simpleType name="EndpointHealthState_t">
            <restriction base="string">
                <enumeration value="critical"/>
                <enumeration value="ok"/>
                <enumeration value="other"/>
                <enumeration value="unknown"/>
                <enumeration value="warning"/>
            </restriction>
        </simpleType>

        <simpleType name="EndpointTechnology_t">
            <union memberTypes="string">
                <simpleType>
                    <restriction base="string">
```

```
                <enumeration value="corba"/>
                <enumeration value="jndi"/>
                <enumeration value="webservice"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="ExpirationMode_t">
    <restriction base="string">
        <enumeration value="neverexpire"/>
        <enumeration value="releasewhenexpired"/>
        <enumeration value="warnwhenexpired"/>
    </restriction>
</simpleType>

<simpleType name="ExtendedBoolean_t">
    <restriction base="string">
        <enumeration value="true"/>
        <enumeration value="false"/>
        <enumeration value="undefined"/>
    </restriction>
</simpleType>

<simpleType name="InterfaceName_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="ogf.bes"/>
                <enumeration value="ogf.srm"/>
                <enumeration value="emi.executionservice"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="JobDescription_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="condor:classad"/>
                <enumeration value="glite:jdl"/>
                <enumeration value="globus:rsl"/>
                <enumeration value="nordugrid:xrsl"/>
                <enumeration value="ogf:jsdl"/>
                <enumeration value="emi:adl"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="License_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="commercial"/>
                <enumeration value="opensource"/>
                <enumeration value="unknown"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="NetworkInfo_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="100megabitethernet"/>
```

```
                        <enumeration value="gigabitethernet"/>
                        <enumeration value="infiniband"/>
                        <enumeration value="myrinet"/>
                </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="OSFamily_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="linux"/>
                <enumeration value="macosx"/>
                <enumeration value="solaris"/>
                <enumeration value="windows"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="OSName_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="aix"/>
                <enumeration value="centos"/>
                <enumeration value="debian"/>
                <enumeration value="fedora"/>
                <enumeration value="gentoo"/>
                <enumeration value="leopard"/>
                <enumeration value="snowleopard"/>
                <enumeration value="mandrake"/>
                <enumeration value="redhatenterprise"/>
                <enumeration value="scientificlinux"/>
                <enumeration value="suse"/>
                <enumeration value="ubuntu"/>
                <enumeration value="windowsxp"/>
                <enumeration value="windows7"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="ParallelSupport_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="mpi"/>
                <enumeration value="openmp"/>
                <enumeration value="none"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="Platform_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="amd64"/>
                <enumeration value="i386"/>
                <enumeration value="itanium"/>
                <enumeration value="powerpc"/>
                <enumeration value="sparc"/>
            </restriction>
        </simpleType>
    </union>
```

```
        </simpleType>

    <simpleType name="PolicyScheme_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="basic"/>
                    <enumeration value="gacl"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="QualityLevel_t">
        <restriction base="string">
            <enumeration value="development"/>
            <enumeration value="pre-production"/>
            <enumeration value="production"/>
            <enumeration value="testing"/>
        </restriction>
    </simpleType>

    <simpleType name="ReservationPolicy_t">
        <restriction base="string">
            <enumeration value="mandatory"/>
            <enumeration value="none"/>
            <enumeration value="optional"/>
        </restriction>
    </simpleType>

    <simpleType name="SchedulingPolicy_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="fairshare"/>
                    <enumeration value="fifo"/>
                    <enumeration value="random"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="ServiceType_t">
        <annotation>
            <documentation source="https://github.com/OGF-
GLUE/Enumerations/blob/master/ServiceType_t.csv"
                xml:lang="en">
                <xhtml:div>
                    <xhtml:p>
                        See the link for the latest set of service type
                        enum values.
                    </xhtml:p>
                </xhtml:div>
            </documentation>
        </annotation>
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="org.ogf.glue"/>
                    <enumeration value="org.glite.fts"/>
                    <enumeration value="org.glite.lb"/>
                    <enumeration value="org.glite.wms"/>
                    <enumeration value="org.nordugrid.accounting.mars"/>
                    <enumeration value="org.nordugrid.execution.arex"/>
                    <enumeration value="org.nordugrid.execution.janitor"/>
                    <enumeration value="org.nordugrid.execution.paul"/>
                    <enumeration value="org.nordugrid.execution.sched"/>
                    <enumeration value="org.nordugrid.infosys.eils"/>
```

```
                <enumeration value="org.nordugrid.infosys.isis"/>
                <enumeration value="org.nordugrid.infosys.rte-catalog"/>
                <enumeration value="org.nordugrid.security.charon"/>
                <enumeration value="org.nordugrid.security.delegation"/>
                <enumeration value="org.nordugrid.security.saml"/>
                <enumeration value="org.nordugrid.security.slcs"/>
                <enumeration value="org.nordugrid.storage.ahash"/>
                <enumeration value="org.nordugrid.storage.bartender"/>
                <enumeration value="org.nordugrid.storage.hopi"/>
                <enumeration value="org.nordugrid.storage.librarian"/>
                <enumeration value="org.nordugrid.storage.shepherd"/>
                <enumeration value="org.nordugrid.tests.echo"/>
                <enumeration value="org.nordugrid.tests.echo_java"/>
                <enumeration value="org.nordugrid.tests.echo_python"/>
                <enumeration value="org.nordugrid.tests.isistest"/>
                <enumeration value="org.terragrid.gridftp"/>
                <enumeration value="org.terragrid.condor-g"/>
                <enumeration value="org.terragrid.globus-mds4"/>
                <enumeration value="org.terragrid.gpfs"/>
                <enumeration value="org.terragrid.gsi-openssh"/>
                <enumeration value="org.terragrid.prewsgram"/>
                <enumeration value="org.terragrid.rft"/>
                <enumeration value="org.terragrid.srb"/>
                <enumeration value="org.terragrid.ws-delegation"/>
                <enumeration value="org.terragrid.ws-gram"/>
                <enumeration value="org.terragrid.ws-ogsadai"/>
            </restriction>
        </simpleType>
    </union>
</simpleType>

<simpleType name="ServingState_t">
    <restriction base="string">
        <enumeration value="closed"/>
        <enumeration value="draining"/>
        <enumeration value="production"/>
        <enumeration value="queueing"/>
    </restriction>
</simpleType>

<simpleType name="Staging_t">
    <restriction base="string">
        <enumeration value="none"/>
        <enumeration value="stagingin"/>
        <enumeration value="staginginout"/>
        <enumeration value="stagingout"/>
    </restriction>
</simpleType>

<simpleType name="StorageAccessProtocolType_t">
    <union memberTypes="string">
        <simpleType>
            <restriction base="string">
                <enumeration value="afs"/>
                <enumeration value="dcap"/>
                <enumeration value="file"/>
                <enumeration value="gsidcap"/>
                <enumeration value="gsiftp"/>
                <enumeration value="gsirfio"/>
                <enumeration value="http"/>
                <enumeration value="https"/>
                <enumeration value="nfs"/>
                <enumeration value="rfio"/>
                <enumeration value="root"/>
                <enumeration value="xrootd"/>
                <enumeration value="uftp"/>
            </restriction>
        </simpleType>
```

```
            </union>
    </simpleType>

    <simpleType name="StorageCapacity_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="online"/>
                    <enumeration value="installedonline"/>
                    <enumeration value="nearline"/>
                    <enumeration value="installednearline"/>
                    <enumeration value="offline"/>
                    <enumeration value="cache"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="StorageManagerType_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="castor"/>
                    <enumeration value="dcache"/>
                    <enumeration value="enstore"/>
                    <enumeration value="gpfs"/>
                    <enumeration value="sse"/>
                    <enumeration value="tsm"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="RetentionPolicy_t">
        <union memberTypes="string">
            <simpleType>
                <restriction base="string">
                    <enumeration value="custodial"/>
                    <enumeration value="output"/>
                    <enumeration value="replica"/>
                </restriction>
            </simpleType>
        </union>
    </simpleType>

    <simpleType name="Latitude_t">
        <restriction base="float">
            <minInclusive value="-90"/>
            <maxInclusive value="90"/>
        </restriction>
    </simpleType>

    <simpleType name="Longitude_t">
        <restriction base="float">
            <minExclusive value="-180"/>
            <maxInclusive value="180"/>
        </restriction>
    </simpleType>

    <simpleType name="LocalID_t">
        <restriction base="string">
            <pattern value="[a-zA-Z][a-zA-Z_0-9\-\.:]*"/>
        </restriction>
    </simpleType>

    <simpleType name="ID_t">
        <restriction base="anyURI">
        </restriction>
```

```
    </simpleType>
    <!-- END DATA TYPES -->
</schema>
```