

GWD-R
Usage Record Working Group
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Aggregate Usage Representation Recommendation (Version 1.0)

Status of This Document

This document describes the format for usage information representation in aggregate or summarized format. This document is a draft and keeps to be updated. Distribution of this document is unlimited.

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Abstract

Grid accounting requires usage information to be shared in a common format between resource providers. The usage information can be shared in OGF-UR format for atomic job accounting as well as in summarized format for aggregate accounting. This document describes usage properties and XML infoset representation enabling usage information to be shared in the aggregate format. An aggregate usage record accumulates job-level usage information for other level usage tacking. Aggregate properties specified in this document are intended to accommodate flexible aggregation or decomposition to other levels, in the perspectives of both resource consumer and resource provider. Extensions are also provided for custom definitions.

This document concentrates on the common format definition and does not address how aggregate usage data to be used, data interoperability with other storage format, and communication mechanism and security.

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1. Introduction

1.1 Background

Usage record schema defined in OGF Usage Record (UR) [OGF-UR] has evolved and narrowed its scope into the XML representation of usage information at atomic level, the job level. This document focuses on usage representation in aggregate or summary format. The usage record conforming to the representation in this document is known as aggregate usage record. Unlike job usage in OGF-UR format, the aggregate usage record requires to provide grid-wide properties for jobs to be aggregated for various usage tracking. The user aggregate record, for example, summarizes usage information of jobs on the name of a particular user during a period of time. The jobs may span multiple sites and belong to multiple Virtual Organizations (VOs). An aggregation usage record could also be further decomposed into finer-granularity aggregate groups through combination of one or more aggregate properties. The aim of this document is to provide a generic representation format for sharing usage information in aggregation format with approximately flexibilities to accommodate various aggregation purposes. Some properties and attributes of OGF-UR standard are reused in this document with aggregate semantics.

1.2 Context

Basic to the understanding of grid accounting is to provide an accurate view of usage information. The usage information records the job transaction information between stakeholders and resource providers. For grid jobs running across administrative domains, the usage information is required to be represented in a common format for sharing among sites. This formatted usage information is known as a usage record. A usage record encapsulates usage information of a single job or a collection of jobs. The latter is known as aggregate usage record. This specification deals with aggregate usage representation based on following contexts:

- The grid is composed of a set of physical and logical resources from the resource provider point of views;
- The grid is composed of a group of grid users associated with membership and access policies to resources from the perspective of resource consumers;
- Grid users consume resources through jobs, which are accounted and recorded in OGF-UR format;

Therefore, the aggregate representation described in this document SHOULD provide aggregate view of OGF-UR compatible job usage information from both resource provider and consumer perspectives.

1.3 Scope

This document concentrates on representation of aggregate usage records in XML format and does not consider how these records are intended to be used. A site could also use other storage mechanisms for usage representation, such as SQL relational database. However, the mapping to local storage mechanism is out scope of this document and depends on local implementation or other standards. The specification has close relationship with OGF-UR standard, which means an aggregate usage record is supposed to be produced by summarizing a group of job usage information in the format of OGF-UR. It is also possible to track back to job usage records from an aggregate usage record. In this document, potential linkage between job usage accounting is described based on shared properties and does not consider the implementation.

2. Notational Conventions

2.1 Key Words

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this specification are to be interpreted as described in IETF RFC 2119 [RFC2119]:

“they MUST only be used where it is actually required for interoperation or to limit behavior which has potential for causing harm (e.g. limiting retransmission)”

These key words are thus capitalized when used to unambiguously specify requirements over features and behavior that affect interoperability and security of implementations.

2.2 Namespaces

Aggregate usage schema recommended in this document is based on OGF-UR schema with extensions for aggregate properties. The namespace used in aggregate XML schema is supposed to be same as OGF-UR (version 1.9) as well as other namespaces associated with OGF-UR schema. The following table shows prefix/namespace lists used in the aggregate usage schema.

Prefix	Namespace
aur	http://schema.ogf.org/urf/2006/12/aggregate-usage-record
urf	http://schema.ogf.org/urf/2003/09/urf
ds	http://www.w3.org/2000/09/xmlsig#
xsd	http://www.w3.org/2001/XMLSchema
xsi	http://www.w3.org/2001/XMLSchema-instance

2.3 User Properties

User properties are those items that give semantic attributes to all or most grid users. These properties are intended to be used to provide accurate ownership for aggregate jobs as well provides finer-grain aggregation decompositions.

2.4 Resource Properties

Resource properties are those items that identify resources consumed by a group of jobs. These properties give rich identifications for physical resources and logical resources and for single work node, to a computing cluster.

2.5 Consumption Properties

The consumption properties describe usage status of aggregate jobs in a usage record.

2.6 Common Properties

Common properties describe the shared properties for all aggregate usage representations.

2.7 Aggregate Properties

User properties, resource properties and consumption properties are collectively known as aggregate properties.

2.8 Meta Properties

Meta properties used in the document are from OGF-UR specification to provide consistent semantic meanings for job-level base properties and aggregate properties. Readers can refer to OGF-UR specification for more details.

3 Aggregate Properties

The aggregate properties listed in this section aims at providing terms for various aggregation purposes. Some of aggregate properties share fields defined in OGF-UR but with semantic clarification in the context of aggregate accounting. Additional properties are further defined to provide grid-wide view in the perspectives of both resource consumers and providers. Appendix A gives detailed construction process of aggregate property definitions. The value of these properties can be either obtained directly from job usage record provider in OGF-UR format or from other grid components, such as information service and VO membership service. Sharing aggregate usage records is required to reach certain agreement on certain aggregate properties between exchange communities.

3.1 User Properties

The following lists aggregate properties in the context of ownership of aggregated jobs to provide user-level accounting and associated aggregate decomposition.

3.1.1 GlobalUserName

This property describes the global user identity of jobs aggregated in the usage record. The value of this property SHOULD be able to uniquely identify the user in a grid environment. The property may be the distinguished name of X.509 user certificate or other user accounts uniquely specified in the grid environment or multi-grid environments. The existence of “GlobalUserName” property indicates the usage information in the record is aggregated from jobs submitted by the user.

- This property SHOULD be referred to as “*GlobalUserName*”;
- This property is defined in OGF-UR;
- This property is optional;

3.1.2 LocalUserId

This property describes the local user identity of the jobs aggregated in the usage record. The local user identity may refer to the same or different global users. The existence of “LocalUserId” property indicates the usage information in the record is aggregated from jobs sharing the same local user identity in running systems.

- This property SHOULD be referred to as “*LocalUserId*”;
- This property is defined in OGF-UR;
- This property is optional;

3.1.3 UserFQAN

This property describes the user unique attributes, known as “Fully Qualified Attribute Name”, in the scope of virtual organization membership. The property is composed of basic four parts, the VO, group/subgroup, role and capability based on [RFC 3281] attribute certificate. The “UserFQAN” property contributes to flexible decompositions of aggregate usage representation into jobs belonging to a group, roles and/or capabilities.

- This property SHOULD be referred to as “*UserFQAN*”;
- This property is optional;
- This property MUST have data type of string;
- This property MAY have “description” meta property defined in OGF-UR;

3.1.4 VOName

This property describes the virtual organization identity of jobs aggregated in the usage record. The existence of the “VOName” property indicates the usage information in the record is aggregated from jobs belonging to a particular VO.

- This property SHOULD be referred to as “*VOName*”;
- This property is optional;
- This property MUST have data type of string;
- This property MAY have “description” meta property defined in OGF-UR;

3.1.5 **ProjectName**

This property describes the project identity associated with jobs aggregated in the usage record. The property MAY identify with the effective GID under which aggregate jobs consumed resources;

- This property SHOULD be referred to as “*ProjectName*”;
- This property is defined in OGF-UR;
- This property is optional;

3.2 Resource Properties

The following lists aggregate properties in the context of resource provider contributing to various aggregation purposes of jobs submitted to logical or physical resources.

3.2.1 **SiteName**

This property describes the administrative identity of a set of resources installed in an organization. The existence of the “*SiteName*” property in an aggregate usage record indicates the usage information is summarized from jobs submitted to a set of resources managed by an organization or administrative domain. The value of this property may be the domain name of the site or global unique name in other formats.

- This property SHOULD be referred to as “*SiteName*”;
- This property is optional;
- This property MUST have data type of string;
- This property May have “description” meta property defined in OGF-UR;

3.2.2 **ClusterId**

This property represents the identity of a set of physical resources, working nodes or hosts. A cluster may be divided into one or more logical resources hosted by different batch queue systems. The existence of the “*cluster*” property in a usage record indicates the usage information is summarized from jobs submitted to any working nodes or hosts in the cluster. The value of this property SHOULD uniquely identify the cluster of shared resources in global grid environment.

- This property SHOULD be referred to as “*ClusterId*”;
- This property is optional;
- This property MUST have data type of string;
- This property May have the “description” meta property defined in OGF-UR;

3.2.3 **Queue**

This property represents the grid abstraction of a set of logical resources managed by a batch queue system. Multiple queues may share resources in the same cluster. A queue system provides management of jobs and offers execution environment. The existence of the “*Queue*” property in a usage record indicates the usage information is aggregated for jobs submitted to resources managed by the same backend batch system. The value of this property SHOULD uniquely identify the logical resources in global grid environment.

- This property SHOULD be referred to as “*Queue*”;
- This property is defined in OGF-UR;

- This property is optional;

3.2.4 **Host**

This property represents the system hostname on which a group of jobs ran. The “Host” property in an aggregate usage record constraints the aggregation of jobs on the same host.

- This property SHOULD be referred to as “*Host*”;
- This property is defined in OGF-UR;
- This property is optional;

3.2.5 **MachineName**

This property describes the machine identity where a group of jobs consumed resources. The “MachineName” property in an aggregate usage record indicates the usage information summarized is constrained in the machine.

- This property SHOULD be referred to as “*MachineName*”;
- This property is defined in OGF-UR;
- This property is optional;

3.2.6 **SubmitHost**

This property represents the host name from which a group of jobs are submitted.

- This property SHOULD be referred to as “*SubmitHost*”;
- This property is defined in OGF-UR;
- This property is optional;

3.2.7 **ServiceLevel**

This property describes the quality of service associated with resource consumption of jobs aggregated in the usage records, for example, the total usage information of jobs with same service priority.

- This property SHOULD be referred to as “*ServiceLevel*”;
- This property is defined in OGF-UR;
- This property is optional;

3.3 Common Properties

The following lists the common properties of aggregate usage records.

3.3.1 **Status**

This property describes status of a group jobs aggregated in the usage record.

- This property SHOULD be referred to as “*Status*”;
- This property is defined in OGF-UR;
- This property is optional;

3.3.2 **NumberOfJobs**

This property describes the number of jobs aggregated in a usage record.

- This property SHOULD be referred to as “*NumberOfJobs*”;
- This property is optional;
- This property MUST have data type of integer;

3.3.3 **StartTime**

This property describes the starting point of a period of time associated with aggregate jobs in the usage record;

- This property SHOULD be referred to as “*StartTime*”;
- This property is defined in OGF-UR;
- This property is optional;

3.3.4 **EndTime**

This property describes the end point of a period of time associated with aggregate jobs in the usage record;

- This property SHOULD be referred to as “*EndTime*”;
- This property is defined in OGF-UR;
- This property is optional;

3.3.5 **RecordIdentity**

This property provides globally unique identity for an aggregate usage record. The “RecordIdentity” May contain the “When/Who” attributes for aggregation time and aggregation endpoint. The aggregation endpoint is referred to “ds:keyInfo” data type to encapsulate the X.509 certificate information of the aggregate user or service. The key information embedded in the record identity MAY be used to encrypt the aggregate usage record or critical properties of the aggregate usage record in order to ensure reliable and secure data exchange.

- This property SHOULD be referred to as “*RecordIdentity*”;
- This property is defined in OGF-UR;
- This property is required;
- It is recommended to have “When/Who” attribute pair for an aggregate usage record;
- This property REQUIRES a “recordId” attribute as a string for globally unique identity of the aggregate usage record;

3.4 Consumption Properties

The following lists the resource usage/consumption properties of an aggregate usage record. These properties all come from the OGF-UR definitions but with aggregate semantics.

3.4.1 **WallDuration**

This property describes sum wall clock time of every single job in the aggregate group represented in the usage record. The property may be also represented with metric attributes for the maximum, average, or minimum wall clock time. To keep compatible with current OGF-UR without metric property for this property, the WallDuration property here reuse the one defined in OGF-UR, but leave the “description” meta property for metric description. This property may also be used for elapsed time of DAG jobs to record the continuous wall clock time elapsed for all jobs that are port of the DAG.

```
e.g. <urf:WallDuration description="total">45234</urf:WallDuration>
     <urf:WallDuration description="max">234</urf:WallDuration>
     <urf:WallDuration description="DAGMan">367</urf:WallDuration>
```

- This property SHOULD be referred to as “*WallDuration*”;
- This property is defined in OGF-UR;
- This property is optional;

3.4.2 **CpuDuration**

This property describes sum CPU time of every single job in the aggregate group represented in the usage record. This property may also be used for representation of maximum, minimum, average or other usage metrics for grouped jobs.

- This property SHOULD be referred to as “*CpuDuration*”;
- This property is defined in OGF-UR;
- This property is optional;

3.4.3 **Disk**

This property describes sum disk storage usage of jobs aggregated in the usage record.

- This property SHOULD be referred to as “*Disk*”;
- This property is defined in OGF-UR;
- This property is optional;

3.4.4 **Swap**

This property describes sum swap usage of jobs aggregated in the usage record.

- This property SHOULD be referred to as “*Swap*”;
- This property is as defined in OGF-UR;
- This property is optional;

3.4.5 **Memory**

This property describes sum memory storage used for jobs aggregated in the usage record.

- This property SHOULD be referred to as “*Memory*”;
- This property is defined in OGF-UR;
- This property is optional;

3.4.6 **Network**

This property describes sum network resources used for jobs aggregated in the usage record.

- This property SHOULD be referred to as “*Network*”;
- This property is defined in OGF-UR;
- This property is optional;

3.4.7 **Charge**

This property describes the total charge used for jobs aggregated in the usage record.

- This property SHOULD be referred to as “*Charge*”
- This property is defined in OGF-UR;
- This property is optional;

3.4.8 **Processors**

This property describes number of processors consumed by jobs aggregated in the usage record.

- This property SHOULD be referred to as “*Processor*”;
- This property is defined in OGF-UR;
- This property is optional;

3.4.9 **NodeCount**

This property describes the number of work nodes used for jobs aggregated in the usage record.

- This property SHOULD be referred to as “*NodeCount*”;
- This property is as defined in OGF-UR;
- This property is optional;

3.4.10 **TimeDuration**

This property describes additional measure of time duration that is relevant to jobs aggregated in the usage record. For example, the total waiting time before jobs to be served.

- This property SHOULD be referred to as “*TimeDuration*”;
- This property is as defined in OGF-UR;
- This property is optional;

3.5 Extension Properties

The extension properties contribute to extensive framework for custom resource properties and aggregate group properties out the scope of aggregate properties specified in this document.

4 Aggregate Usage Schema

4.1 Global Data Type Definition

4.1.1 **AggregateUsageType** Complex Type

This complex type definition describes the structure of the generic aggregate usage record. The combination of aggregate properties introduced in chapter 3 contributes to the content model of *AggregateUsageType*.

The definition of *AggregateUsageType* content model conforms to following rules:

- Common aggregate properties are supposed to be defined before to any other properties.
- The only mandatory element is the *RecordIdentity*, which gives global identity of an aggregate usage instance among usage storage.
- Aggregate group properties are grouped together and divided into three parts, user properties, resource properties, and other group properties including the extension framework, which SHOULD appear in sequence.
- If multiple aggregate group properties appear, they MUST be defined directly after the aggregate group in the same context keeping the global definition in sequence. For example, if a usage record is intended to record aggregate usage for two users from different VOs, the user group properties are supposed to be defined together before any resource and aggregate extension properties.
- Consumption properties MUST be defined after any aggregate group properties.
- If any OGF-UR resource extension definition appears, custom resource properties MUST be defined within the consumption property group;

```
<xsd:complexType name="AggregateUsageRecordType" >
  <xsd:sequence>
    <!-- common properties -->
    <xsd:element ref="urf:RecordIdentity" minOccurs="1" maxOccurs="1"
  />
```

```

<xsd:element ref="urf:Status" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:StartTime" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:EndTime" minOccurs="0" maxOccurs="1" />
<xsd:element ref="aur:NumberOfJobs" minOccurs="0" maxOccurs="1" />
/>

<!-- user aggregate properties -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:annotation>
<xsd:documentation>The following provides VO-view aggregate
properties. These elements are allowed to be arranged in any order
and any occurrence. If more than once occurrence, values of these
elements should be different to ensure the uniqueness of
particular aggregate properties.
</xsd:documentation>
</xsd:annotation>
<xsd:element ref="aur:UserIdentity" minOccurs="0" maxOccurs="1" />
/>
</xsd:choice>

<!-- resource aggregate properties -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:annotation>
<xsd:documentation>
The following provides resource-provider view aggregate
properties. These elements are allowed to be arranged in any
order and any occurrence. If more than once occurrence, values or
attributes of these elements should be different to ensure the
uniqueness of the particular aggregate properties.
</xsd:documentation>
</xsd:annotation>
<xsd:element ref="aur:ResourceIdentity" minOccurs="0"
maxOccurs="1" />
</xsd:choice>

<!-- the following gives aggregation from other perspectives -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="urf:ProjectName" minOccurs="0"
maxOccurs="1" />
<xsd:element ref="urf:SubmitHost" minOccurs="0"
maxOccurs="1" />
<xsd:element ref="urf:ServiceLevel" minOccurs="0"
maxOccurs="1" />
</xsd:choice>

<!-- extension framework -->

<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="aur:Group" minOccurs="0" maxOccurs="unbounded" />
</xsd:choice>

<!-- usage consumption properties -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="urf:WallDuration" minOccurs="0" maxOccurs="1" />
</xsd:choice>
<xsd:sequence maxOccurs="1" minOccurs="0">

```

```

<xsd:element ref="urf:CpuDuration" minOccurs="0" maxOccurs="2" />
</xsd:sequence>
<xsd:element ref="urf:TimeDuration" minOccurs="0" maxOccurs="1" />
/>
<xsd:element ref="urf:Disk" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Memory" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Network" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Swap" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Processors" minOccurs="0" maxOccurs="1" />

<xsd:element ref="urf:NodeCount" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Charge" minOccurs="0" maxOccurs="1" />

<!-- resource extension framework -->
<xsd:sequence maxOccurs="1" minOccurs="0">
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="urf:PhaseResource" />
<xsd:element ref="urf:VolumeResource" />
<xsd:element ref="urf:Resource" />
<xsd:element ref="urf:ConsumableResource" />
</xsd:choice>
</xsd:sequence>
</xsd:choice>

</xsd:sequence>
</xsd:complexType>

```

4.1.2 FQAN Simple Type

This data type describes the descriptive format for Full Qualified Attribute Name [FQAN] used by Virtual Organization Management Service (VOMS) to provide further attribute description of a grid user. A FQAN value specifies virtual organization, groups, subgroups, roles and capabilities of a grid user in string format. The combination of these attribute names contribute to decomposition of aggregation groups. The syntax of FQAN value was proposed in the format: “*VO[/Group][/Role=role][/Capability=cap]*”. Considering other custom FQAN syntax used, GACL for example, the FQAN simple type in this specification is defined as single string with restriction for nothing.

```

<xsd:simpleType name="FQAN">
<xsd:restriction base="xsd:string" />
</xsd:simpleType>

```

4.1.3 NameType Simple Type

This simple data type describes the global name description in human-readable format.

```

<xsd:simpleType name="NameType">
<xsd:restriction base="xsd:string" />
</xsd:simpleType>

```

4.1.4 IdType Simple Type

This simple data type describes the global unique identity.

```

<xsd:simpleType name="IdType">
<xsd:restriction base="xsd:string" />
</xsd:simpleType>

```

4.2 Global Element Definition

4.2.1 **AggregateUsageRecords** Element

This is the root element for an aggregate usage XML declaration. This element allows multiple “AggregateUsageRecord” embedded within a single aggregate usage record document.

```
<xsd:element name="AggregateUsageRecords">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element ref="aur:AggregateUsage" minOccurs="0"
maxOccurs="unbounded" />
    </xsd:sequence>
  </xsd:complexType>
</xsd:element>
```

4.2.2 **AggregateUsage** Element

This element describes the structure of a valid aggregate usage record in XML format. The information set encapsulated within this element allows combination of aggregation levels for various decomposed aggregation. The element is defined as abstract for an extensible point. Extensive XML schema from this element will result in incompatibility of aggregation representation described in this document. It is the responsibility for sites and grid to exchange aggregate usage information with agreement on custom definition of aggregation elements that are out of the scope described in this document. It is also recommended to use extension framework if finer-granularity decomposition of aggregation levels are required.

```
<xsd:element name="AggregateUsage" type="urf:AggregateUsageType"
abstract="true" />
```

4.2.3 **Aggregate** Element

This element definition provides an OGF-UR compatible entry point for establishment of aggregate usage record as it derives from the “AggregateUsageRecordType” defined in this document. As with OGF-UR clarification of aggregate accounting, the aggregate properties are contained within the “aggregate” property as well as those base properties defined in OGF-UR.

```
<xsd:element name="Aggregate" substitutionGroup="aur:AggregateUsage">
  <xsd:complexType>
    <xsd:complexContent>
      <xsd:extension base="aur:AggregateUsageRecordType" />
    </xsd:complexContent>
  </xsd:complexType>
</xsd:element>
```

4.2.4 **AggregateUsageRecord** Element

This element an entry for construction of aggregate usage records as syntax and semantic meaning defined in this document without derivations.

```
<xsd:element name="AggregateRecord" type="urf:AggregateUsageType"
  substitutionGroup="AggregateUsage" />
```

4.2.5 **UserIdentity** Element

This element describes a particular user information and associated membership in VO(s). The definition of this element is composed of two parts: the user identity information and VO membership information. The user identity information part is from the *UserIdentity* element defined in OGF-UR. This element is redefined in aggregate usage schema is mainly because, the content model of “*urf:UserIdentity*” is defined based on “Russia-doll” pattern, which makes the extensible difficult. The content model of this element SHOULD conform to following rules:

- All sub-elements of “*urf:UserIdentity*” are reused in exactly same structure;
- The VO membership information are grouped and May appear multiple times but MUST be defined after user information;
- VO membership information provides facilities to the VO and group/subgroup level accounting.

```
<xsd:element name="UserIdentity">
  <xsd:complexType>
  <xsd:sequence>
  <xsd:element name="LocalUserId" type="xsd:string" minOccurs="0"
    maxOccurs="1" />
  <xsd:element name="GlobalUserName" type="xsd:string"
    minOccurs="0" maxOccurs="1" />
  <xsd:element ref="ds:KeyInfo" minOccurs="0" maxOccurs="1" />
  <xsd:choice minOccurs="0" maxOccurs="1">
  <xsd:sequence maxOccurs="unbounded" minOccurs="0">
  <xsd:element ref="aur:UserFQAN" minOccurs="0" maxOccurs="1"/>
  <xsd:element ref="aur:VOName" minOccurs="0" maxOccurs="1" />
  </xsd:sequence>
  </xsd:choice>
  </xsd:sequence>
  </xsd:complexType>
  </xsd:element>
```

4.2.6 **ResourceIdentity** Element

This element acts as a container of resource aggregate properties. All resource aggregate properties MUST be defined and embedded in this element with content model conforming to following rules:

- If *GlobalResourceIdentity* appears, it MUST be defined before any other properties to describe the global identity of resource the aggregate jobs were executed or submitted. The value of this element MAY be the computing element identity;
- Other resource aggregate properties are grouped together and MAY appears more than once;

```
<xsd:element name="ResourceIdentity">
  <xsd:complexType>
  <xsd:sequence>
  <xsd:element name="GlobalResourceId" type="aur:IdType"
    minOccurs="0" maxOccurs="1" />
  <xsd:choice minOccurs="0" maxOccurs="1">
```

```

<xsd:sequence minOccurs="0" maxOccurs="unbounded">
  <xsd:element ref="aur:SiteName" minOccurs="0" maxOccurs="1"/>
  <xsd:element ref="aur:ClusterId" minOccurs="0" maxOccurs="1" />
  <xsd:element ref="urf:Queue" minOccurs="0" maxOccurs="1" />
  <xsd:element ref="urf:MachineName" minOccurs="0" maxOccurs="1" />
  <xsd:element ref="urf:Host" minOccurs="0" maxOccurs="1" />
</xsd:sequence>
</xsd:choice>
</xsd:sequence>
</xsd:complexType>
</xsd:element>

```

4.2.7 **NumberOfJobs** Element

This element provides the total number of jobs aggregated in a usage record;

```

<xsd:element name="NumberOfJobs" type="xsd:int" />

```

4.3 Aggregate Properties

4.3.1 **SiteName** Element

This element specifies the administrative site name. The value of the “SiteName” element is represented either by the domain name of the machine with gatekeeper installed or numeric string, and SHOULD be able to uniquely identify a site in the grid-wide scope.

```

<xsd:element name="SiteName">
  <xsd:complexType>
  <xsd:simpleContent>
  <xsd:extension base="aur:NameType">
  <xsd:attribute ref="urf:description" use="optional" />
  </xsd:extension>
  </xsd:simpleContent>
  </xsd:complexType>
</xsd:element>

```

4.3.2 **ClusterId** Element

This element specifies the cluster identity of jobs aggregated in a usage record. The value of this element SHOULD be able to uniquely identify a physical cluster in the grid-wide scope.

```

<xsd:element name="ClusterId">
  <xsd:complexType>
  <xsd:simpleContent>
  <xsd:extension base="aur:IdType">
  <xsd:attribute ref="urf:description" use="optional" />
  </xsd:extension>
  </xsd:simpleContent>
  </xsd:complexType>
</xsd:element>

```

4.3.3 **VOName** Element

This element identifies a particular VO of usage. The value of this element SHOULD identify a VO in the grid-wide scope.

```

<xsd:element name="VOName">
  <xsd:complexType>
    <xsd:simpleContent>
      <xsd:extension base="aur:NameType">
        <xsd:attribute ref="urf:description" use="optional" />
      </xsd:extension>
    </xsd:simpleContent>
  </xsd:complexType>
</xsd:element>

```

4.3.4 UserFQAN Element

This element provides FQAN attributes of a grid user. The “UserFQAN” element could be used either for attribute description of a grid user or providing aggregation for collective jobs belonging to users in a particular group, subgroup, role or capability. This element is referred to the “FQAN” data type definition.

```

<xsd:element name="UserFQAN">
  <xsd:complexType>
    <xsd:simpleContent>
      <xsd:extension base="aur:FQAN">
        <xsd:attribute ref="urf:description" use="optional" />
      </xsd:extension>
    </xsd:simpleContent>
  </xsd:complexType>
</xsd:element>

```

4.4 Extension Framework

The extension framework proposed in this document provides an extensible entry for custom aggregate group definition. It is also to use OGF-UR resource extension framework for additional properties out scope of the documents and OGF-UR document.

4.4.1 GroupType Data Type

This type definition provides a mechanism to represent custom aggregate group information of jobs to be aggregated. For example, LCG is mostly like to have an aggregate property to specify country name so that a group of jobs consumed resources from UK can be accounted.

```

<xsd:complexType name="GroupType">
  <xsd:simpleContent>
    <xsd:extension base="xsd:string">
      <xsd:attribute ref="urf:description" use="optional" />
    </xsd:extension>
  </xsd:simpleContent>
</xsd:complexType>

```

4.4.2 Group Element

This is an optional element referred to the “GroupType” and used for custom aggregation property definition.

```
<xsd:element name="Group" type="aur:GroupType" />
```

5 Data Interoperability

The schema in this document describes a common representation recommendation of aggregate usage records in XML instances, but by no means limited to. Accounting usage records can also be represented in various formats depending on underlying storage, relational database for instance. To enable data interoperability of sharing accounting usage records, it is recommended to convert local storage format into XML instance. The mapping/conversion rules are out of scope of this document and depend on local implementations or other standards.

Aggregate usage records summaries usage information in high level, data interoperability of an aggregate usage record is also required to exhibit connectivity to job accounting records encapsulated, in turn realizing the linkage between aggregate and job accounting. Hence the data interoperability between job and aggregate usage records require semantic agreements on certain usage properties among sites. For example, sites may agree on the “urf:ProjectName” or “urf:Resource” for job-level VO representation and trace back to job usage details from an usage record with the same VO value. This document does not specify semantic agreements between job and aggregate usage properties and leaves it to accounting implementations.

6 Security Considerations

There may be security concerns that should be addressed with respect to usage data. Possible security issues might include:

- Non-repudiation
- Confidentiality of certain elements
- Integrity
- Secure Transport

Recommendation of required solutions for these security concerns are out of scope for this layer. Another layer should address the necessary security requirements.

7 Sample Aggregate Usage Records

7.1 Sample 1

A site manager would like to know how resources provided are consumed periodically (monthly). The example below reports summary usage information of top two users.

```
<?xml version="1.0" encoding="UTF-8"?>
<aur:AggregateUsageRecords
xmlns:aur="http://schema.ogf.org/urf/2006/07/aggregate-usage-
record" xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
xmlns:urf="http://schema.ogf.org/urf/2003/09/urf"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://schema.ogf.org/urf/2006/07/aggregate-
usage-record aggregate-ur-1.1.xsd
http://www.w3.org/2000/09/xmldsig# http://www.w3.org/TR/xmldsig-
```

```

core/xmlldsig-core-schema.xsd http://schema.ogf.org/urf/2003/09/urf
urwg-schema.19.xsd ">
  <aur:Aggregate>
    <urf:RecordIdentity urf:createTime="2006-12-18T14:23:44"
urf:recordId="3748">
      <ds:KeyInfo>
        <ds:X509Data>
          <ds:X509SubjectName>
            C=UK, OU=eScience, U=Brunel, L=ECE, CN=xiaoyu chen
          </ds:X509SubjectName>
        </ds:X509Data>
      </ds:KeyInfo>
    </urf:RecordIdentity>

    <urf:StartTime urf:description="">2001-11-
01T00:00:00</urf:StartTime>
    <urf:EndTime urf:description="">2001-11-
30T11:59:59</urf:EndTime>
    <aur:NumberOfJobs>3945</aur:NumberOfJobs>
    <aur:UserIdentity>
      <aur:GlobalUserName>user01</aur:GlobalUserName>
      <aur>UserFQAN
urf:description="">/VO1/group10/Role=user</aur>UserFQAN>
      <aur>VOName urf:description="">VO1</aur>VOName>
      <aur>UserFQAN
urf:description="">/VO2/group01/Role=admin</aur>UserFQAN>
      <aur>VOName urf:description="">VO2</aur>VOName>
    </aur>UserIdentity>
    <aur>UserIdentity>
      <aur:GlobalUserName>user02</aur:GlobalUserName>
      <aur>UserFQAN
urf:description="">/VO1/group01/Role=admin</aur>UserFQAN>
      <aur>VOName urf:description="">VO1</aur>VOName>
    </aur>UserIdentity>

    <aur:ResourceIdentity>
      <aur:SiteName urf:description="">Site46</aur:SiteName>
    </aur:ResourceIdentity>

    <urf:WallDuration
urf:description="SpecFloatInt2000">PT23H</urf:WallDuration>
    <urf:Processors>76</urf:Processors>
    <urf:NodeCount>23</urf:NodeCount>
    <urf:Memory urf:storageUnit="MB">64</urf:Memory>

  </aur:Aggregate>
</aur:AggregateUsageRecords>

```

7.2 Sample 2

There is a site that provides resources accessible for all VOs, but two hosts exclusively for LHCb and CMS VO. The following aggregate usage examples gives the aggregate usages information of these two VOs running on different resources (logical or physical) and gives a clear comparison between resource allocations for these two VOs. Suppose the site provides two computing elements (PBS and Condor pool) with a cluster of 20 hosts.

The following usage record summarizes usage information of LHCb and CMS VOs on those two dedicated hosts.

```
<?xml version="1.0" encoding="UTF-8"?>
<aur:AggregateUsageRecords
xmlns:aur="http://schema.ogf.org/urf/2006/07/aggregate-usage-
record" xmlns:ds="http://www.w3.org/2000/09/xmlnsig#"
xmlns:urf="http://schema.ogf.org/urf/2003/09/urf"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://schema.ogf.org/urf/2006/07/aggregate-
usage-record aur.xsd http://www.w3.org/2000/09/xmlnsig#
http://www.w3.org/TR/xmlnsig-core/xmlnsig-core-schema.xsd
http://schema.ogf.org/urf/2003/09/urf urwg-schema.19.xsd ">
  <aur:Aggregate>
    <urf:RecordIdentity urf:createTime="2006-10-29T12:00:00"
urf:recordId="54321">
      <ds:KeyInfo>
        <ds:X509Data>
          <ds:X509SubjectName>
            C=UK, OU=eScience, U=Brunel, L=ECE, CN=xiaoyu chen
          </ds:X509SubjectName>
        </ds:X509Data>
      </ds:KeyInfo>
    </urf:RecordIdentity>
    <urf:StartTime urf:description="aggregation starts from">
      2006-12-19T00:00:00
    </urf:StartTime>
    <urf:EndTime urf:description="aggregation ends till">
      2006-12-19T10:00:00
    </urf:EndTime>
    <aur:NumberOfJobs>3826556</aur:NumberOfJobs>

    <!-- User Properties -->
    <aur:UserIdentity>
      <aur:VOName>LHCb</aur:VOName>
    </aur:UserIdentity>
    <aur:UserIdentity>
      <aur:VOName>CMS</aur:VOName>
    </aur:UserIdentity>

    <!-- resource properties -->
    <aur:ResourceIdentity>
      <urf:Host urf:description="dedicated to
LHCb">lchb.ce01.ral.ac.uk</urf:Host>
      <urf:Host urf:description="dedicated to
CMS">cms.ce01.ral.ac.uk</urf:Host>
    </aur:ResourceIdentity>

    <!-- consumption properties -->
    <urf:WallDuration
urf:description="SpecInt2000">PT286H</urf:WallDuration>
    <urf:NodeCount>2</urf:NodeCount>
    <urf:Processors>4</urf:Processors>

  </aur:Aggregate>
</aur:AggregateUsageRecords>
```

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Appendix A. Survey

A1. Survey Background

An aggregate usage representation is intended to accommodate various aggregate views in both virtual organization and resource provider points of view. A Virtual Organization (VO) aggregate usage record, for example, outlines summary usage information of jobs belonging to a particular VO or subordinated groups of a period of time. From the virtual organization point of view, a grid maintains membership of Grid users or consumers organized in group with fine-grain access policies. The membership and access policies defined within a virtual organization indicate potential clues for aggregate property definitions that contribute to flexible decomposition of aggregation groups. On the other hand, a grid is also composed of resources or services from sharing communities. These resources are coordinated to be allocated for authorized job executions. In this sense, job usage information can be grouped and aggregated in the context of both physical and logical resources.

Therefore, a survey is performed based on current Grid components and protocols in order to define common terms for aggregate properties. Some of usage properties are reused from OGF-UR definition with specific semantics in the context of aggregate accounting.

The survey is based on current VO membership management service and authorization services (VOMS, CAS, GridSite, PERMIS and Akenti) for VO perspective as well as the information service (MDS and [Glue Schema]) and cluster information providers (HawkEye, Ganglia, MonaLisa and Sun Grid Engine accounting system) from the resource provider perspective.

A2. Survey Results

Terms used current systems and services	Terms defined in OGF-UR	Data Type	Description
VO, Virtual Organization, VO view, Sponsor	N/A	CHAR	Identity of a virtual organization which can be represented in DNS format or unique numeric name.
group, subgroup, groupname, GID	N/A	CHAR	A group is a set of users, which may also contain other group and in turn forming group-subgroups hierarchical structure. The virtual organization can be looked as the root group.
role, admin, RID	N/A	CHAR	Role is specified as user's properties. A role may contain a set of users from different groups. A user can take more than one roles in a group as well.
Capability, AID, cname, read, write, list, permission ...	N/A	CHAR	Capability defines users' access priorities to resources, and can be used to describe the users' special characteristics.
fqan, voms	N/A	CHAR	The "Fully Qualified Attribute Name" specifies user properties and characteristics in [RFC 3218] attribute certificate. The value of FQAN combination of the names of users' membership properties and characteristics in the format of: <i>"/VO[/GROUP][/ROLE=role][/CAPABILITY=cap]"</i>
user, distinguished name, dn, person, credential, ACCOUNT, UID	urf:UserIdentity	CHAR	Global user identity
Site	urf:MachineName	CHAR	The site represents set of resources installed at a site.
Cluster, Subcluster, Pool,	urf:MachineName	N/A	Logic view of actual software components
Computing Element	N/A	CHAR	The identity of a logic cluster of computing resources managed with gatekeeper and job manager installed.
Host, HostName, SubmitHost, ExecutionHost, AdminHost, MasterHost,	urf: Host		Status description of a computing element
Queue, Job Queue	urf:MachineName	"cms", "atlas", "lhcb"	The view of virtual organization of a computing element

Appendix B. Aggregate Properties and Semantics

Aggregate Property	Semantics
VirtualOrganization	Summary usage information of jobs belonging to a particular virtual organization
Queue	Summary usage information of jobs submitted from the queue
Cluster	Summary usage information of jobs running in a cluster, which could be subcluster of a cluster.
FQAN	Summary usage information of jobs belonging to a certain member, group, role, and capability subordinated to a particular virtual organization
UserIdentity	Summary usage information of jobs belonging to a user;
SiteName	Summary usage information of jobs running at resources belonging to a site
Host	Summary usage information of jobs running in a Host;
MachineName	Summary usage information of jobs running in a machine;
Status	Summary usage information of jobs with a certain status at the creation time of this aggregate usage record
StartTime	The start point of aggregation period
EndTime	The ending point of aggregate period

Appendix C. Aggregate Usage Record XML Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema attributeFormDefault="qualified"
elementFormDefault="qualified"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:urf="http://schema.ogf.org/urf/2003/09/urf"
xmlns:aur="http://schema.ogf.org/urf/2006/07/aggregate-usage-record"
xmlns:ds="http://www.w3.org/2000/09/xmlsig#"
targetNamespace="http://schema.ogf.org/urf/2006/07/aggregate-usage-
record"
>
<xsd:annotation>
<xsd:documentation xml:lang="en">Aggregate Usage Record XML
Schema</xsd:documentation>
</xsd:annotation>
<xsd:import namespace="http://www.w3.org/2000/09/xmlsig#"
schemaLocation="http://www.w3.org/TR/xmlsig-core/xmlsig-core-
schema.xsd" />
<xsd:import namespace="http://schema.ogf.org/urf/2003/09/urf"
schemaLocation="urwg-schema.19.xsd" />
<xsd:complexType name="AggregateUsageRecordType">
<xsd:sequence>
<!-- common properties -->
<xsd:element ref="urf:RecordIdentity" minOccurs="1" maxOccurs="1" />
<xsd:element ref="urf>Status" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:StartTime" minOccurs="0" maxOccurs="1" />
```

```

<xsd:element ref="urf:EndTime" minOccurs="0" maxOccurs="1" />
<xsd:element ref="aur:NumberOfJobs" minOccurs="0" maxOccurs="1" />

<!-- user aggregate properties -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:annotation>
<xsd:documentation>The following provides VO-view aggregate
properties. These elements are allowed to arranged in any order and
any occurrence. If more than once occurrences, values of these
elements should be different to ensure the uniqueness of particular
aggregate properties.
</xsd:documentation>
</xsd:annotation>
<xsd:element ref="aur:UserIdentity" minOccurs="0" maxOccurs="1" />
</xsd:choice>

<!-- resource aggregate properties -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:annotation>
<xsd:documentation>
The following provides resource-provider view aggregate properties.
These elements are allowed to be arranged in any order and any
occurrence. If more than once occurrence, values or attributes of
these elements should be different to ensure the uniqueness of the
particular aggregate properties.
</xsd:documentation>
</xsd:annotation>
<xsd:element ref="aur:ResourceIdentity" minOccurs="0" maxOccurs="1"
/>
</xsd:choice>

<!-- the following gives aggregation from other perspectives -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="urf:ProjectName" minOccurs="0" maxOccurs="1"
/>
<xsd:element ref="urf:SubmitHost" minOccurs="0" maxOccurs="1"
/>
<xsd:element ref="urf:ServiceLevel" minOccurs="0"
maxOccurs="1" />
</xsd:choice>

<!-- extension framework -->

<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="aur:Group" minOccurs="0" maxOccurs="unbounded" />
</xsd:choice>

<!-- usage consumption properties -->
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="urf:WallDuration" minOccurs="0" maxOccurs="1" />
<xsd:sequence maxOccurs="1" minOccurs="0">
<xsd:element ref="urf:CpuDuration" minOccurs="0" maxOccurs="2" />
</xsd:sequence>
<xsd:element ref="urf:TimeDuration" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Disk" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Memory" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Network" minOccurs="0" maxOccurs="1" />

```



```

<xsd:element ref="urf:Swap" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Processors" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:NodeCount" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Charge" minOccurs="0" maxOccurs="1" />

<!-- resource extension framework -->
<xsd:sequence maxOccurs="1" minOccurs="0">
<xsd:choice maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="urf:PhaseResource" />
<xsd:element ref="urf:VolumeResource" />
<xsd:element ref="urf:Resource" />
<xsd:element ref="urf:ConsumableResource" />
</xsd:choice>
</xsd:sequence>
</xsd:choice>

</xsd:sequence>
</xsd:complexType>

<!-- global properties -->
<xsd:element abstract="true" name="AggregateUsage"
type="aur:AggregateUsageRecordType" />
<xsd:element name="Aggregate"
substitutionGroup="aur:AggregateUsage">
<xsd:complexType>
<xsd:complexContent>
<xsd:extension base="aur:AggregateUsageRecordType" />
</xsd:complexContent>
</xsd:complexType>
</xsd:element>
<xsd:element name="AggregateUsageRecord"
type="aur:AggregateUsageRecordType"
substitutionGroup="aur:AggregateUsage" />
<xsd:element name="AggregateUsageRecords">
<xsd:complexType>
<xsd:sequence>
<xsd:element ref="aur:AggregateUsage" minOccurs="0"
maxOccurs="unbounded" />
</xsd:sequence>
</xsd:complexType>
</xsd:element>

<!-- aggregate properties -->
<xsd:element name="UserIdentity">
<xsd:annotation>
<xsd:documentation>
The user identity element encapsulates one user information and
associated membership in VOs. A grid user may participate in one or
more VOs. The missing of user identities (global and local) while
keeping membership information contributes to the VO and group level
accounting.
</xsd:documentation>
</xsd:annotation>
<xsd:complexType>
<xsd:sequence>
<xsd:element name="LocalUserId" type="xsd:string" minOccurs="0"
maxOccurs="1" />

```

```

<xsd:element name="GlobalUserName" type="xsd:string" minOccurs="0"
maxOccurs="1" />
<xsd:element ref="ds:KeyInfo" minOccurs="0" maxOccurs="1" />
<xsd:choice minOccurs="0" maxOccurs="1">
<xsd:sequence maxOccurs="unbounded" minOccurs="0">
<xsd:element ref="aur:UserFQAN" minOccurs="0" maxOccurs="1"/>
<xsd:element ref="aur:VOName" minOccurs="0" maxOccurs="1" />
</xsd:sequence>
</xsd:choice>
</xsd:sequence>
</xsd:complexType>
</xsd:element>

<xsd:element name="ResourceIdentity">
<xsd:annotation>
<xsd:documentation>
The Resource Identity encapsulates one resource information and
associated properties.The Resource described here could be anything,
a single machine, cluster, logical CE/Queue or Site name.
</xsd:documentation>
</xsd:annotation>
<xsd:complexType>
<xsd:sequence>
<xsd:element name="GlobalResourceId" type="aur:IdType" minOccurs="0"
maxOccurs="1" />
<xsd:choice minOccurs="0" maxOccurs="1">
<xsd:sequence minOccurs="0" maxOccurs="unbounded">
<xsd:element ref="aur:SiteName" minOccurs="0" maxOccurs="1"/>
<xsd:element ref="aur:ClusterId" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Queue" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:MachineName" minOccurs="0" maxOccurs="1" />
<xsd:element ref="urf:Host" minOccurs="0" maxOccurs="1" />
</xsd:sequence>
</xsd:choice>
</xsd:sequence>
</xsd:complexType>
</xsd:element>

<xsd:element name="SiteName">
<xsd:complexType>
<xsd:simpleContent>
<xsd:extension base="aur:NameType">
<xsd:attribute ref="urf:description" use="optional" />
</xsd:extension>
</xsd:simpleContent>
</xsd:complexType>
</xsd:element>

<xsd:element name="ClusterId">
<xsd:complexType>
<xsd:simpleContent>
<xsd:extension base="aur:IdType">
<xsd:attribute ref="urf:description" use="optional" />
</xsd:extension>
</xsd:simpleContent>
</xsd:complexType>
</xsd:element>

```

```

<xsd:element name="UserFQAN">
  <xsd:complexType>
    <xsd:simpleContent>
      <xsd:extension base="aur:FQAN">
        <xsd:attribute ref="urf:description" use="optional" />
      </xsd:extension>
    </xsd:simpleContent>
  </xsd:complexType>
</xsd:element>
<xsd:element name="VOName">
  <xsd:complexType>
    <xsd:simpleContent>
      <xsd:extension base="aur:NameType">
        <xsd:attribute ref="urf:description" use="optional" />
      </xsd:extension>
    </xsd:simpleContent>
  </xsd:complexType>
</xsd:element>

<xsd:element name="NumberOfJobs" type="xsd:int" />

<!-- global type definitions -->

<xsd:simpleType name="FQAN">
  <xsd:restriction base="xsd:string" />
</xsd:simpleType>

<xsd:simpleType name="IdType">
  <xsd:restriction base="xsd:string" />
</xsd:simpleType>

<xsd:simpleType name="NameType">
  <xsd:restriction base="xsd:string" />
</xsd:simpleType>

<!-- extension framework -->
<xsd:element name="Group" type="aur:GroupType" />
<xsd:complexType name="GroupType">
  <xsd:simpleContent>
    <xsd:extension base="xsd:string">
      <xsd:attribute ref="urf:description" use="optional" />
    </xsd:extension>
  </xsd:simpleContent>
</xsd:complexType>
</xsd:schema>

```