Experiences with the GLUE information schema in the LCG/EGEE production Grid

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Overview

- Why we need a schema
- The GLUE project
- How GLUE is used in the LCG/EGEE Grid
- Experience, successes and problems
- Outlook

- This talk focuses on the use of the GLUE schema in the LCG/EGEE Grid – other Grids are available!

Why do we need a schema?

- **A Grid consists of many sites with a wide variety of resources**
- **Users, applications and middleware need to know what resources are available and what their properties are**
  - What Resource Brokers are available to CMS?
  - Find a Computing Element running SL4 with > 2 Gb memory
  - Find a Storage Element with 20 Tb of free space
- **Grid management and operations staff need an overview of the state of the Grid**
  - How many jobs are running in the UK?
  - How much disk space has ATLAS used?
- **The schema allows the resource properties to be published and queried in a uniform way**

- **The information is transported via an information system, but the schema is logically independent of it**

Desirable schema properties

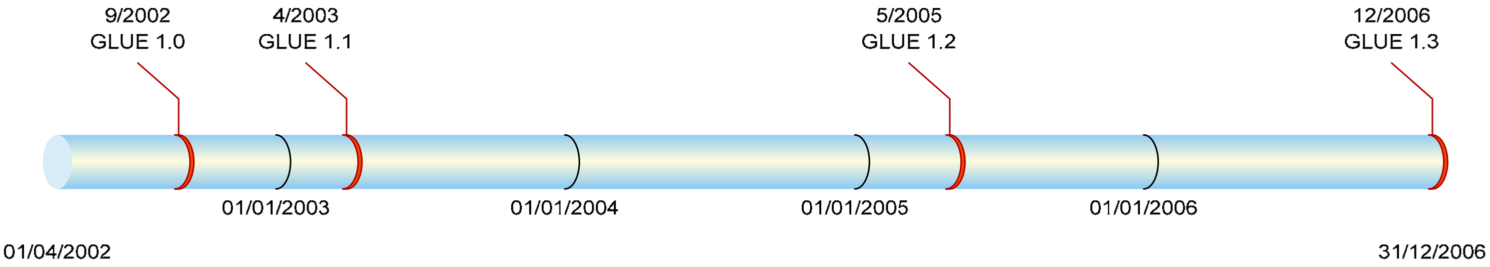
- **Not too big** – don’t describe every detail, only the things which are really needed
- **Not too small** – need to capture all the important features
- **Flexible** – must be able to cope with a very wide range of resource configurations
- **Precise** – the semantics should be clear and unambiguous
- **Simple** – easy to understand what the attributes mean
- **Calculable** – it should be possible to determine the values of attributes in a short time (typically < 1 second)
- **Extensible** – it must be possible to evolve the schema without breaking existing software

Why standardise the schema?

- **Many different Grids, interoperability is a major activity**
  - For WLCG this means EGEE, OSG and NDGF
- **Must publish the same information, with the same names and semantics**
  - At least for a core set of attributes
  - Even trivial differences, e.g. units or case of text, can cause problems
  - Can sometimes write translators between different schemas, but this is complex and error-prone
- **Different Grids can learn from each other's experience**
  - And avoid duplicating work
- **But need to focus on what is really needed**
  - Standardisation activities can be slow
  - Design by committee not always optimal

GLUE history

- **The European DataGrid project (predecessor of EGEE) initially had its own schema (2001)**
- **The GLUE (Grid Laboratory for a Uniform Environment) project was a collaboration between EDG, EU DataTAG, iVDGL (predecessor of OSG) and Globus to promote interoperability**
  - The GLUE schema 1.0 was defined in September 2002 after several months of discussion
  - Version 1.1 was released with some minor improvements in April 2003, and deployed by EDG and then LCG and EGEE
  - Version 1.2 was agreed in February 2005, finalised during 2005 and deployed (fairly gradually) by LCG/EGEE in 2006
  - Version 1.3 was agreed in October 2006 and is starting to be deployed now



Evolution process

- **Evolution has been fairly slow – two upgrades in four years**
  - Collect problems and ideas, discuss by email/phone – several months
  - One face-to-face meeting to agree changes – intensive but productive
  - Write documentation, update schema implementations and deploy them – also a few months
  - Update information providers – timescale varies, can be 1-2 years
  - Update clients – timescale varies, can be infinite!
- **Backward compatibility maintained through the whole process – significant constraint**
  - Some sites take a very long time to upgrade
  - Many legacy objects/attributes

Evolution issues

- **The schema touches everything (middleware, users, sysadmins, …) so lots of dependencies**
  - But most people are not schema experts
  - Small group involved directly in defining the schema, most with other jobs
- **GLUE must meet the needs of many different Grids**
  - Current contributors include EGEE, OMII-Europe, KnowArc, TERAGRID, NAREGI, UNICORE, NGS, OSG, APACGrid, …
- **Different implementation technologies**
  - Currently LDAP, relational (R-GMA), classad, XML
  - Places constraints on structure
    - No tables or primary keys in LDAP
    - No multivalued attributes in a relational schema
    - classads are flat lists

Schema structure

- **The schema is defined in an abstract UML format**
  - Objects with attributes and relations
  - Attributes have types, can be single- or multi-valued
- **GlueSite – describes a Grid site**
  - Location, contacts, affiliation, …
- **GlueService – describes attributes of a generic service**
  - Type, endpoint, status, ACL, …
- **GlueCE – a complex set of objects and attributes describing a computing resource**
  - Queue, policy, cluster, …
- **GlueSE – a complex set of objects and attributes describing a storage resource**
  - Storage area, control and access protocols, policies, …
- **Also many subsidiary objects**

GLUE schema in LCG/EGEE

- **The Resource Broker allows job submission to be directed according to requirements on the GLUE schema attributes, and a ranking expression defines the order of preference**
  - JDL (Job Definition Language) uses classads, which need to be mapped to the schema
- **The data management clients query the information system for the attributes of Storage Elements**
- **Other tools present information directly to the user**
- **Monitoring tools collect summary information for the whole Grid**
- **The storage schema is currently used for a prototype storage accounting system**
  - Although this is not in general a target use for the schema

Service discovery

- **Glue 1.2 introduced the GlueService concept to publish generic service information**
  - gLite has a Service Discovery API to query it
  - Can publish some service-specific information (key/value pairs)
- **Slow takeup**
  - Mainly data management so far
- **GlueService is not explicitly linked to GlueCE/SE**
  - Clients may make ad-hoc assumptions to link them, e.g. matching hostnames
- **No generic information provider**
  - Just static configuration
  - Some services have custom publishers
  - New publisher now being certified

Mapping the schema

- **Real systems are very varied and complex**
  - The schema is uniform and simple
- **Not always obvious how to relate the two**
  - Usually have to make assumptions and simplifications
  - May be wrong, or generate mismatches between sites
- **CE: now have a framework with plugins for each batch system**
  - Uniform assumptions, common code where possible
- **SE: main target is SRM, but still under development**
- **First priority is to err on the safe side**
  - Beware of black holes!
- **If an attribute isn’t used people may not be careful to get it right, so then it can’t be used!**
- **Need schema validation tools to check for sanity**

Publishing the information

- **Need a precise definition of attributes, even where it seems trivial**
  - Long discussion about OS names (not defined in schema)
- **Sysadmins ideally should not need to define things by hand**
  - Typos, misunderstanding of semantics
- **Are attributes optional?**
  - Technically yes in most cases, but not always obvious what it means
  - Usually no special value to mean N/A
- **Units must be clear**
  - Gb vs Gib etc
- **Information providers sometimes slow, can load the system**
  - Introduce caching, but then the information is older
- **Some things are hard to calculate**
  - EstimatedResponseTime
  - Used/Free space for storage
- **Mistakes/hacks can be hard to fix**
  - Incorrect assumptions get embedded in client code

CE issues

- **Basic structure is CE – Cluster – SubCluster**
  - CE is a batch queue, cluster is the hardware
  - SubClusters are homogeneous groups of nodes
  - Original schema design had many detailed host-level attributes – largely unused
- **Resource Broker can't choose SubClusters, so the concept isn't usable**
  - In practice we have one heterogeneous subcluster per cluster
- **Queue concept for CE too simple**
  - Some batch systems have no queues
  - Usually have fairshares within a queue
  - Glue 1.2 introduced the VOView to represent a share
- **Some ambiguities in mapping to real systems**
  - CPUs vs job slots
  - Memory per node, or per job?
- **No information about disk space for scratch files**

SE issues

- **Original schema was defined for "classic SE" – simple disk server + gridftp**
  - Plus other access protocols, e.g. rfio, file
- **Now using Storage Resource Manager (SRM)**
  - In transition from SRM v1 to v2
- **GLUE schema v 1.3 has several enhancements for SRM**
  - But not much experience yet – just starting to deploy it
- **Lots of debate about free/used/available/reserved space**
  - Schema defines lots of attributes, we will see what can be published

Interaction with users

- **Users need to understand the meaning and limitations of the schema attributes**
- **Production users now often have complex Requirement/Rank expressions built up from years of experience**
  - Ordinary users may be less sophisticated
- **Users often ignore attributes which are "usually" not relevant**
  - Max queued jobs, OS type, CPU/wallclock time limits, …
- **Need frameworks to shield users from the details**

Summary

- **The GLUE schema has developed over 6 years of practical use by EDG/LCG/EGEE**
  - And other Grids
- **It has proved to be sufficient to allow many users to submit large numbers of jobs, manage data and monitor the Grid**
  - No show stoppers
- **However, many rough edges**
  - But now we know where most of the problems lie
- **GLUE is now an OGF working group**
  - Aiming for a major redesign – GLUE 2.0
  - Includes experience from many more Grids
  - See poster session
  - … watch this space!