



ID: INFNGRID20030615-1800

Version: v1.2

Date: April 1, 2004

A Grid Computing Dictionary

Andrea Caltroni

INFN-Padova (andrea.caltroni@pd.infn.it)

Abstract: *A Grid Computing Dictionary*

Contents

1	Grid Organizations and Projects	3
2	Grid Computing	4
3	Grid Tools	7
3.1	Condor	7
3.2	The Globus Project	7
4	Physics and the Grid	8
5	Other	9

1 Grid Organizations and Projects

CrossGRID [EU] CrossGrid is an European R&D project, which aims to develop, implement and exploit new Grid components for interactive computing and data intensive applications. The CrossGrid middleware will enable the deployment of a distributed computing infrastructure allowing access to high-end computational resources across Europe. This environment will be used to develop interactive parallel applications addressing large-scale problems in fields such as earth science, surgical procedures, environmental protection, flood prediction, and physics analysis and simulation.

<http://www.eu-crossgrid.org/>

DataTag [USA-EU, 2001-2004] The fundamental objective of the DataTAG project is to create a large-scale intercontinental Grid testbed involving the European DataGrid project, several national projects in Europe, and related Grid projects in the USA.

- WP1: Establishment of a high performance intercontinental Grid testbed. To provision the necessary network components to enable the creation of an intercontinental high bandwidth Grid testbed in connection with other US Grid projects such as GriPhyN, PPDG and iVDGL.
- WP2: High performance networking. To demonstrate and make available, through the middleware layers, the performance data transport and advanced traffic management services required for Grid operations.
- WP3: Bulk data transfer validations and application performance monitoring. To evaluate existing monitoring tools and if necessary adapt them. To study, and design new tools to validate the intercontinental infrastructure and provide information to understand user perceived performance.
- WP4: Interoperability between Grid domains. To address issues of middleware interoperability between the European and US Grid domains and to enable a selected set of applications to run on the transatlantic Grid test bed.
- WP5: Information dissemination and exploitation. To ensure that the results of the project are widely disseminated and that the results are exploited by existing and future Grid development projects.
- WP6: Project Management. To put in place the necessary structures to ensure the appropriate management of the DataTAG project and the successful delivery of its proposed work.

<http://datatag.web.cern.ch/datatag/>

EDG [EU, 2001-2004] *European Data Grid*. EU funded project to develop middleware based on the Globus and Condor toolkits and deploy testbeds for specific scientific applications (HEP, Earth Observation, Bio-informatics).

- WP1: Grid Work Scheduling Work package.
- WP2: Grid Data Management Work Package.
- WP3: Grid Monitoring Services Work Package.
- WP4: Fabric Management Work package. The objective of this package is to develop new automated system management techniques that will enable the deployment of very large computing fabrics constructed from mass market components with reduced systems administration and operations costs. The fabric must support an evolutionary model that allows the addition and replacement of components, and the introduction of new technologies, while maintaining service. The fabric management must be demonstrated in the project in production use on several thousand processors, and be able to scale to tens of thousands of processors.
- WP5: Mass Storage Management Work Package.
- WP6: Integration Testbed and Demonstrators Work package.
- WP7: Network Services Work package.

<http://eu-datagrid.web.cern.ch/eu-datagrid/>

DataGrid Home at CNR: <http://web.datagrid.cnr.it/>

Datagrid Project Central Repository: <http://datagrid.in2p3.fr/>

INFN Grid Home Page: <http://server11.infn.it/>

INFN Certification Authority: <http://security.fi.infn.it/CA/>

EGEE [EU, 2004-2006] EGEE (Enabling Grids for E-Science in Europe) aims to integrate current national, regional and thematic Grid efforts, in order to create a seamless European Grid infrastructure for the support of the European Research Area. This infrastructure will be built on the EU Research Network GEANT and exploit Grid expertise that has been generated by projects such as the EU DataGrid project, other EU supported Grid projects and the national Grid initiatives such as UK e- Science, INFN Grid, Nordugrid and the US Trillium (cluster of projects).

The EGEE vision is that this Grid infrastructure will provide European researchers in academia and industry with a common market of computing resources, enabling round-the-clock access to major computing resources, independent of geographic location. This infrastructure will support distributed research communities, including relevant Networks of Excellence, which share common Grid computing needs and are prepared to integrate their own distributed computing infrastructures and agree common access policies. The resulting infrastructure will surpass the capabilities of local clusters and individual supercomputing centres in many respects, providing a unique tool for collaborative compute-intensive science ("e-Science") in the European Research Area. Finally, the infrastructure will provide interoperability with other Grids around the globe, including the US NSF Cyberinfrastructure, contributing to efforts to establish a worldwide Grid infrastructure.

<http://egee-intranet.web.cern.ch/egee-intranet/gateway.html>

GGF *Global Grid Forum*. The Global Grid Forum (GGF) is a community-initiated forum of thousands of individuals from industry and research leading the global standardization effort for grid computing. GGF's primary objectives are to promote and support the development, deployment, and implementation of Grid technologies and applications via the creation and documentation of "best practices" - technical specifications, user experiences, and implementation guidelines.

GriPhyN [USA] *Grid Physical Network*.

<http://www.griphyn.org/>

Virtual Data Toolkit: <http://www.lsc-group.phys.uwm.edu/vdt/>

HENP-INTERGRID The HEPN Grid R&D projects (initially DataGrid, GriPhyN, and PPDG, as well as the national European Grid projects in UK, Italy, Netherlands and France) have agreed to coordinate their efforts to design, develop and deploy a consistent open source standards-based global Grid infrastructure. The guidelines for coordination and joint development by the projects are enunciated below.

<http://www.hicb.org/>

iVDGL [USA] *International Virtual Data Grid Laboratory*.

<http://www.ivdgl.org/>

LHC Computing Grid [EU] The accelerator will start operation in 2007 and will be used to answer the most fundamental questions of science by some 6,000 people from universities and laboratories all around the world. The computational requirements of the experiments that will use the LHC are enormous: 12-14 PetaBytes of data will be generated each year. The goal of the LCG project is to meet these unprecedented computing needs by deploying a worldwide computational grid service, integrating the capacity of scientific computing centres spread across Europe, America and Asia into a virtual computing organisation.

<http://lcg.web.cern.ch/LCG/>

Ninf/ApGRID The Ninf Project is developing Grid technologies which allows users to access various resources such as hardware, software and scientific data on the Grid with an easy-to-use interface. The Ninf system is a Grid RPC system which has been developing by the Ninf Project. Ninf system provides Ninf Remote Procedure Call facilities which is designed to provide a programming interface similar to conventional function calls and enable the user to build Grid-enabled applications.

<http://ninf.apgrid.org/>

PPDG [USA] *Particle Physics Data Grid*. The Particle Physics Data Grid collaboration was formed in 1999 because its members were keenly aware of the need for Data Grid services to enable the worldwide distributed computing model of current and future high-energy and nuclear physics experiments. PPDG is actively participating in iVDGL together with GriPhyN as a three prong approach to data grids for US physics experiments, symbolized by Trillium flower. As well, it is working closely with complementary data grid initiatives in Europe and beyond: GlobalGridForum, European DataGrid and as part of the HENP InterGrid Coordination Board (HICB) and HICB Joint Technical Board.

<http://www.ppdg.net/>

2 Grid Computing

CA *Certification Authority*. A certificate authority (CA) is an authority in a network that issues and manages security credentials and public keys for message encryption. As part of a public key infrastructure (PKI), a CA checks with a registration authority (RA) to verify information provided by the requestor of a digital certificate. If the RA verifies the requestor's information, the CA can then issue a certificate.

CE [Grid] *Computing Element*. A Grid-enabled computing resource.

DIT *Directory Information Tree*. (see LDAP).

GDMP *Grid Data Mirroring (Management?) Package*. Originally developed as a production prototype for evaluating Grid technologies, in particular Globus in context of CMS trigger studies.

GENIUS *Grid Enabled web eNvironment for site Independent User job Submission*.
A project to develop a Grid portal by INFN.
<https://genius.ct.infn.it>

GIS *Grid Information Service*. Example: IMS, Globus MDS.

Globus The Globus Project is a research and development project focused on enabling the application of Grid concepts to scientific and engineering computing.
<http://www.globus.org/>

GLUE *Grid Laboratory Uniform Environment*. A joint project between DataTAG and iVDGL whose objective is to acquire and define software, configuration guidelines and policies to allow Middleware Services developed by the participating Grid Projects to Interoperate. Results must be independent of the particular Data Grid Architecture implementation. Definition, assembly and testing of core common software components of grid middleware drawn from EDG, GriPhyN, PPDG, and others, designed to be part of the base middleware of the grids that will be run by each project. GLUE will not necessarily assemble a complete system of middleware, but will choose components to work on that raise particular issues of interoperability. (Other projects may address some of these issues in parallel before the Glue effort does work on them).
<http://www.hicb.org/glue/glue.htm>

GLUE-SCHEMA The GLUE-SCHEMA effort is sponsored by the HENP Intergrid Joint Technical and Coordination Boards. It aims to define, publish and enable the use of common schemas for interoperability between the EU physics grid project efforts (EDG, DataTag, etc.) and the US physics grid project efforts (iVDGL, PPDG, GriPhyN).
<http://www.cnaf.infn.it/~sergio/datatag/glue/>.
<http://www.hicb.org/glue/glue-schema/schema.htm>

GMA *Grid Monitoring Architecture*. Defined by GGF.

GridICE A GRID monitoring system based on GIS (currently on MDS/GLUE). It is distributed with CMS/LCG-0 and will be distributed with CMS/LCG-1.
<http://server11.infn.it/datatag/monitoring/>

GriFIS *Grid Fabric Information Service*.

GS *Grid Scheduler*.

IDL *Interactive Data Language*.

II *Information Index*. A specialized GIIS used by the RB.

IMS *Information and Monitoring System*. Catalogues and distributes static and dynamic data about the Grid.

JDL *Job Description Language*.

JSS *Job Submission Service*. Submits a job to the target CE.

LB *Logging and Bookkeeping*.

LCAS *Local Center Authorization Service*.

LCFGng LCFG (Next Generation) is a system for automatically installing and managing the configuration of large numbers of Unix systems. It is particularly suitable for sites with very diverse and rapidly changing configurations.// Configuration parameters ("resources") for all machines on a site are stored in a number of "LCFG source files" on a central server. The files describe "aspects" of the site configuration, such as "a web server", or a "Dell Optiplex". Individual machine descriptions can reference appropriate aspects, as well as include their own specific resources. A daemon on the server monitors these files for changes and compiles them into individual XML "profiles" which explicitly describe the complete configuration of each machine. The profiles are published on a web server and downloaded by the corresponding client machines whenever they change. A number of modular "component" scripts on the client are responsible for different subsystems, such as "mail configuration" or "web server configuration". The components are notified when their resources change and are responsible for translating the resources into the appropriate configuration files, and reconfiguring any associated daemons. One component is responsible for synchronizing the set of packages installed on the machine with the list of required packages specified in the profile. New machines can be installed automatically by creating the appropriate source files and booting from a network filesystem using a boot floppy, or PXE. The required package set is installed according to the profile, and the components configure the system in exactly the same way as a fully-installed machine.
<http://www.lcfg.org>

LCMAPS *Local Credential MAPPING Service.*

LDAP *Lightweight Directory Access Protocol.*

LDIF *LDAP Data Interchange Format.*

LFN *Logical File Name.*

lim *Load Information Manager (LIM) for LSF.* LIM is a server that runs on every server host which is participating in load sharing. It provides system configuration information, load information, and placement advice services. The LIMs on all hosts coordinate in collecting and transmitting load information. Load information is transmitted between LIMs in the form of vectors of load indices. These are described in the LOAD INDICES section.

LRAM *Local Resource Access Management.*

LRMS *Local Resource Management System.* Controls resources within a CE (e.g. PBS or LSF).

LSF *Load Sharing Facility.* LSF is a suite of workload management products from Platform Computing Corporation, including:

- LSF Batch - a batch job processing system for distributed and heterogeneous environments
- LSF MultiCluster - supports resource sharing among multiple clusters of computers.

LSF at CERN: <http://www.pdp.web.cern.ch/www.pdp/bis/services/lsf/>

Platform Computing Corporation: <http://www.platform.com/>

MR *Monitoring Repository.*

MSA *Monitoring Sensor Agent.*

MSS *Mass Storage System.*

MUI *Monitoring User Interface.*

NMA *Node Management Agent.*

OGSA *Open Grid Services Architecture.* The Open Grid Services Architecture (OGSA) represents a new vision of both the grid and web services. By defining standard communication protocols and formats, OGSA represents the means to build truly large-scale, interoperable grid systems. The OGSA Working Group in the Global Grid Forum produces a set of documents detailing this vision. The OGSA vision is being instantiated in the Open Grid Services Infrastructure (OGSI).

OGSI *Open Grid Service Infrastructure.* The Open Grid Services Infrastructure (OGSI) is a set of WSDL specifications defining standard interfaces, behaviors, and schema for grid computing consistent with the OGSA vision. These interfaces and behaviors define the Grid Service. The latest version of the OGSI Specification is available from the OGSI Working Group in the Global Grid Forum. The OGSI specification is being implemented on a number of different platforms including .NET (by this project), Java (GT3 from the Globus Project) and others.

PBS *Portable Batch System.* The Portable Batch System, PBS, is the leading workload management solution for HPC systems and Linux clusters. PBS was originally designed for NASA because existing resource management systems were inadequate for modern parallel/distributed computers and clusters. From the initial design forward, PBS has included innovative new approaches to resource management and job scheduling, such as the extraction of scheduling policy into a single separable, completely customizable module.

<http://www.pbspro.com>

PFN *Physical File Name.*

QoS *Quality of Service.*

RA *Registration Authority.* A registration authority (RA) is an authority in a network that verifies user requests for a digital certificate and tells the certificate authority (CA) to issue it. RAs are part of a public key infrastructure (PKI), a networked system that enables companies and users to exchange information and money safely and securely.

RB *Resource Broker.* Locates and selects the target CE: reads a JDL file for user requirements; Finds suitable resources querying the II; finds input data files querying the RC.

RC *Replica Catalog.*

R-GMA *Relational - Grid Monitoring Architecture.* It is a monitoring and information management service for distributed resources. It exposes a relational model with SQL support to provide static as well as dynamic information about Grid resources. It is based on GMA.

RLS *Replica Location Service.*

RM *Replica Manager.*

RMS *Resource Management (Sub)system.*

SAN *Storage Area Network.*

SE *Storage Element.* A Grid-enabled storage resource.

Testbed 0 [DataGRID] Datagrid's initial Globus toolkit deployment

Testbed n [DataGRID] n-th release of DataGRID Software - Year n since first deployment.

UI *User Interface.*

VDT [GriPhyN] *Virtual Data Toolkit.* The Virtual Data Toolkit (VDT) is a set of software that supports the needs of the research groups and experiments involved in the Griphyn project. It contains two types of software:

1. **Fundamental grid software** This includes Condor and Globus. In future releases, VDT will use the NMI software release, which bundles up much of this fundamental grid software.
2. **Virtual Data Software** This includes software developed by the Griphyn project to work with virtual data, such as the Virtual Data System. The VDT does not yet contain any virtual data software in the standard release, but it will in upcoming releases.

VO *Virtual Organization.* A set of users sharing the same application environment. They need application-specific software installed on their testbed, a specific user/machine environment and access to a given set of resources. Examples: Alice, Atlas, CMS, CDF.

VOMS Virtual Organization Membership Service.

WMS Workload Management System. Distributed scheduling and resource management in a Grid environment.

WP Work package.

3 Grid Tools

3.1 Condor

Classid The lingua franca of Condor. Used to describe jobs, workstations and other resources. The ClassAd mechanism in Condor provides an extremely flexible and expressive framework for matching resource requests (jobs) with resource offers (machines). Jobs can easily state both job requirements and job preferences. Likewise, machines can specify requirements and preferences about the jobs they are willing to run. These requirements and preferences can be described in powerful expressions, resulting in Condor's adaptation to nearly any desired policy. Exchanged by Condor processes to schedule jobs. Logged to files. Used to enquire about current state of system. It is a mapping from attribute names to expressions.

Condor Condor is a specialized workload management system for compute-intensive jobs. Like other full-featured batch systems, Condor provides a job queueing mechanism, scheduling policy, priority scheme, resource monitoring, and resource management. Users submit their serial or parallel jobs to Condor, Condor places them into a queue, chooses when and where to run the jobs based upon a policy, carefully monitors their progress, and ultimately informs the user upon completion.

<http://www.cs.wisc.edu/condor/>

Condor-G A version of Condor that works with Globus.

3.2 The Globus Project

GASS *Globus Access to Secondary Storage.* Part of the Globus Toolkit's resource management schema.

GIIS *Grid Information Index Service.* Part of the Globus Toolkit's information services schema. A GIIS provides a means of combining arbitrary GRIS services to provide a coherent system image that can be explored or searched by grid applications. A GIIS thus provides a mechanism for identifying resources of particular interest. For example, a GIIS could list all of the computational resources available within a confederation of laboratories, or all of the distributed data storage systems owned by a particular agency. A GIIS could pool information about all of the grid resources (computation, data, networks, and instruments) in a particular research consortium, thus providing a coherent system image of that consortium's computational grid.

A GIIS accepts registration messages from child GRIS or GIIS instances and merges these information sources into a unified information space. Client searches may obtain information from any or all of the GIIS children. A GIIS can therefore be used to obtain information from multiple GRIS resources via a single command. A GIIS can be set up to act as an organization-wide information server, for a single site or for a multi-site collaboration.

GIIS functionality is implemented as a special purpose back end for an OpenLDAP server.

Globus Toolkit A set of services and software libraries to support Grids and Grid applications. The Toolkit includes software for security, information infrastructure, resource management, data management, communication, fault detection, and portability.

- GNP** Grid Notification Protocol. Used by MDS-2 for lifetime management of published information.
- GRAM** *Grid Resource Allocation and Management*. Part of the Globus Toolkit's resource management schema. Manage access to Grid resources. It is responsible for operating a set of resources under the same site-specific allocation policy or LRAM like LSF, PBF, Condor. A GRAM reporter monitors and publishes information about the identity and state of local computations (registry).
- GridFTP** A Grid-enhanced FTP implementation. Part of the Globus Toolkit's data management schema.
- GRIS** *Grid Resource Information Service*. Part of the Globus Toolkit's information services schema. A GRIS is a distributed information service that can answer queries about a particular resource by directing the query to an information provider deployed as part of the Globus services on a grid resource. Examples of information provided by this service include host identity (e.g., operating systems and versions), as well as more dynamic information such as CPU and memory availability.
A GRIS can respond to queries from other systems on the grid asking for information about a local machine or other specific resource. A GRIS can be configured to register itself with aggregate directory services (such as a GIIS) so that those services can pass on information about the machine to others.
GRIS functionality is implemented as a special purpose back end for an OpenLDAP server.
- GSI** *Grid Security Infrastructure*. The public-key-based GSI protocol provides single sign-on authentication, communication protection, and some initial support for restricted delegation. In brief, single sign-on allows a user to authenticate once and thus create a proxy credential that a program can use to authenticate with any remote service on the user's behalf. Delegation allows for the creation and communication to a remote service of delegated proxy credentials that the remote service can use to act on the user's behalf, perhaps with various restrictions; this capability is important for nested operations. (Similar mechanisms can be implemented within the context of other security technologies, such as Kerberos, although with potentially different characteristics.)
- MDS** *Monitoring and Discovery Service* (old name: Meta Directory Service). Part of the Globus Toolkit's information services schema. MDS provides the necessary tools to build an LDAP-based information infrastructure for computational grids. MDS uses the LDAP protocol as a uniform means of querying system information from a rich variety of system components, and for optionally constructing a uniform namespace for resource information across a system that may involve many organizations. MDS therefore defines an approach to presenting data to users (via the LDAP protocols and some particular schema), and some particular types of servers such as GRIS and GIIS that are part of the Globus Toolkit.
- RSL** *Resource Specification Language*.

4 Physics and the Grid

- Alice** *A Large Ion Collider Experiment at CERN LHC*.
<http://alice.web.cern.ch/Alice/>
- Atlas** *A Toroidal LHC Apparatus*.
<http://atlas.web.cern.ch/Atlas/internal/>
<http://pdg.lbl.gov/atlas/atlas.html>
- BaBar** The BaBar detector was built at SLAC to study the millions of B mesons produced by the PEP-II storage ring. The BaBar collaboration consists of around 600 physicists and engineers from 85 institutions in 9 countries.
<http://www.slac.stanford.edu/BF/>
- CCS** *Cern Classification Standard*.
<http://ais.cern.ch/projs/ccs/welcome.html>
- CMS** *Compact Muon Solenoid*. An Experiment for the Large Hadron Collider at CERN.
<http://cmsinfo.cern.ch/Welcome.html/>
- HENP** *High Energy and Nuclear Physics*.
- HEP** *High Energy Physics*.
- HICB** *HENP Intergrid Coordination Board*.
- HIJTB** *HENP InterGrid Joint Technical Board*.
- IN2p3** Institut National de Physique Nucleaire et de Physique des Particules (CNRS, France)
<http://www.in2p3.fr>
- INFN** *Istituto Nazionale di Fisica Nucleare*. Italian National Institute for Nuclear Physics.
<http://www.infn.it>
- JTB** *Joint Technical Board*.

LCG *The LHC Computing Grid Project.*

<http://lcg.web.cern.ch/LCG/>

LHC *Large Hadron Collider.*

<http://lhc-new-homepage.web.cern.ch/lhc-new-homepage/>

LHCb *Large Hadron Collider b quarks. The LHC's fourth experiment.*

<http://lhcb-public.web.cern.ch/lhcb-public/>

SLAC *Stanford Linear Accelerator Center.* Established in 1962, it is located at Stanford University in Menlo Park, CA. Its mission is to design, construct and operate state-of-the-art electron accelerators and related experimental facilities for use in high-energy physics and synchrotron radiation research.

<http://www.slac.stanford.edu/>

5 Other

Nagios An open source host, service and network monitoring program.

Nagios is a host and service monitor designed to inform you of network problems before your clients, end-users or managers do. It has been designed to run under the Linux operating system, but works fine under most *NIX variants as well. The monitoring daemon runs intermittent checks on hosts and services you specify using external "plugins" which return status information to Nagios. When problems are encountered, the daemon can send notifications out to administrative contacts in a variety of different ways (email, instant message, SMS, etc.). Current status information, historical logs, and reports can all be accessed via a web browser.

<http://www.nagios.org/>.

SOAP The Simple Object Access Protocol provides a means of messaging between a service provider and a service requestor. SOAP is a simple enveloping mechanism for XML payloads that defines a remote procedure call (RPC) convention and a messaging convention. SOAP is independent of the underlying transport protocol; SOAP payloads can be carried on HTTP, FTP, Java Messaging Service (JMS), and the like. We emphasize that Web services can describe multiple access mechanisms to the underlying software component. SOAP is just one means of formatting a Web service invocation.

WSDL The Web Services Description Language is an XML document for describing Web services as a set of endpoints operating on messages containing either documentoriented (messaging) or RPC payloads. Service interfaces are defined abstractly in terms of message structures and sequences of simple message exchanges (or operations, in WSDL terminology) and then bound to a concrete network protocol and data-encoding format to define an endpoint. Related concrete endpoints are bundled to define abstract endpoints (services). WSDL is extensible to allow description of endpoints and the concrete representation of their messages for a variety of different message formats and network protocols. Several standardized binding conventions are defined describing how to use WSDL in conjunction with SOAP 1.1, HTTP GET/POST, and MIME.

XML eXtensible Markup Language.