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THE NORDUGRID/ARC INFORMATION SYSTEM

Technical Description and Reference Manual

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1 Introduction

A stable, robust, scalable, dynamic and reliable information system is a cornerstone of any kind of Grid system. Without a properly working information system it is not possible to construct a production quality Grid. A scalable Grid information system is inherently distributed, a centralized system is not able to cope with the dynamicity of the Grid.

The information system acts as a nervous system of the Grid and its main tasks consist of

- Resource Description: Characterization of Grid resources by specifying static, semi-static and dynamic properties (e.g. information about grid jobs and user quotas are presented as dynamic local resource properties).

Grid clients are relying on the resource description functionality of the information system during their matchmaking and brokering process. Grid monitoring and job status queries also rely on resource description.

- Resource aggregation: Individual resources are connected to an "information mesh" by dynamically registering to some of the information index services. The information index services are responsible for the resource aggregation, they maintain a dynamic list of available grid resources. Furthermore, the index services are connected to each other following a specific topological order. The resulting structure is the "information mesh" of the Grid.

Grid clients performing resource discovery scan the "information mesh" utilizing its topological structure in order to find available grid resources. Therefore resource discovery is delicately coupled to the topological structure of the "information mesh" that is to the resource aggregation process.

The ARC middleware implements a scalable, production quality dynamic distributed information system. The ARC information system has been deployed and being used in a large scale production environment since May 2002. As of writing, the information system aggregates 50 resources providing 5000 CPUs and serves 1000 users and 20 thousands jobs per months.

The ARC information system is an OPENLDAP-based system[?] which makes use of the OPENLDAP modifications provided by the Globus Monitoring and Discovery Services framework[†] [3].

This document presents a technical overview of the ARC grid information system. The document describes the architecture, the implementation of the main components and the NorduGrid/ARC Information model. The document is also intended to serve as reference manual by giving a detailed description of the available Grid information.

2 Overview

The ARC middleware implements a dynamic LDAP-based distributed information system via set of coupled resource lists (index services) and local LDAP databases. The system consists of three main components:

1. the Local Information Trees (LIT)
2. the Index Services (IS)
3. and the Registration Processes (RP)

The local information trees are responsible for resource (computing or storage) description and characterization. The local information is generated on the resource, optionally it is cached. Upon client requests it is presented to the clients via LDAP interface.

[†]ARC aims to replace the Globus MDS modifications by native Openldap functionalities

The main task of the index services is to maintain a dynamic list of resources (LDAP URLs of the local information trees) and index services. The index services are further coupled together implementing a specific topology.

The local information trees make use of the registration processes running locally on the resources in order to list themselves in some of the resource lists maintained by the index services. Registrations are always initiated by the registrants (bottom-up model).

Grid clients such as monitors, web portals or user interfaces perform two type of queries:

1. During the resource discovery process clients query index services in order to collect list of LDAP contact URLs of local information trees describing Grid-connected resources.
2. During a direct resource query the clients directly contact the local information tree by making use of the obtained LDAP contact URLs.

Both type of queries are carried out and served via LDAP protocol.

Figure 1 presents an overview of the ARC information system components.

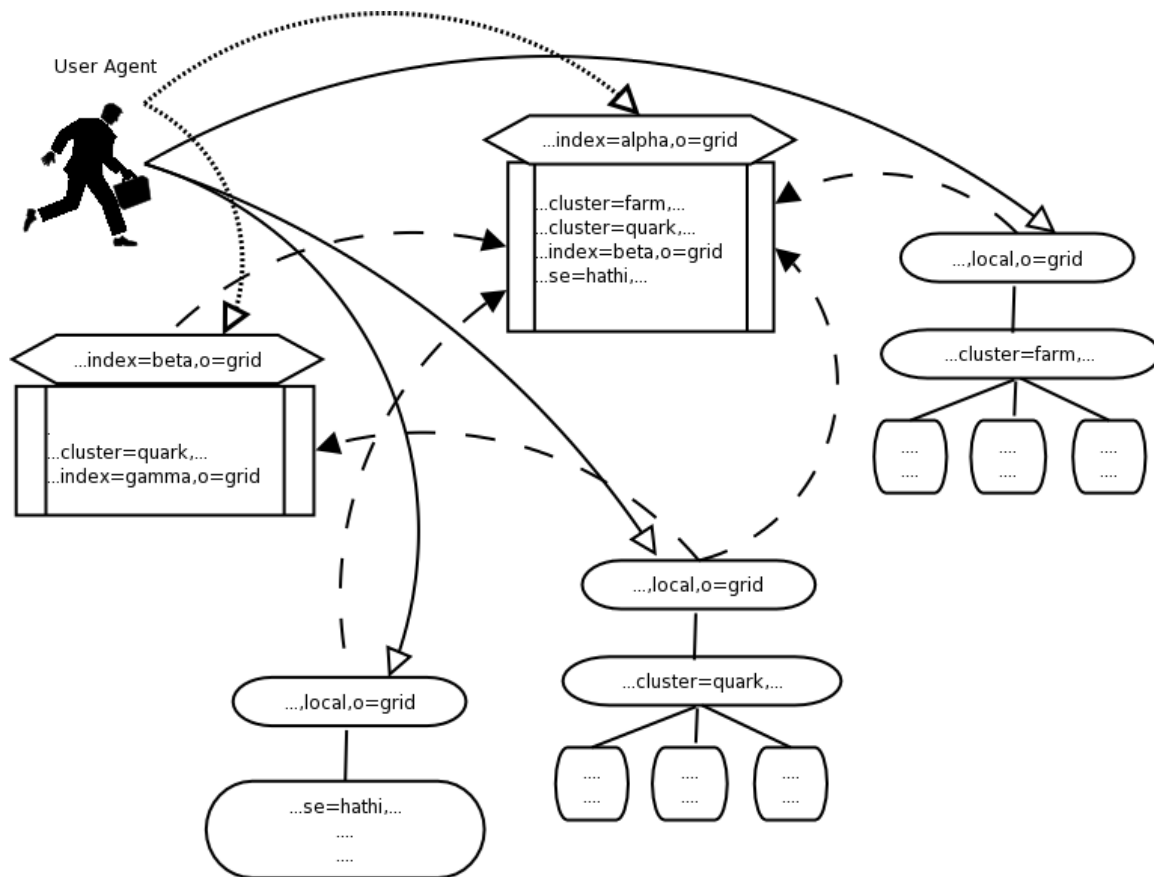


Figure 1: Overview of the ARC information system components.

3 Local Information Tree

The LIT component of the information system is responsible for generating the dynamic state information, implementing the first-level caching of the local information and providing the requested Grid information to the clients through the LDAP protocol. The LIT is basically nothing more but a specially populated and customized OpenLDAP database.

The dynamic resource state information is generated on the resource. Small and efficient programs, called information providers, are used to collect local state information from the batch system, from the local grid

Object Identifier	Service area
1.3.6.1.4.1.11604.1	security
1.3.6.1.4.1.11604.2	information system
1.3.6.1.4.1.11604.3	data management
1.3.6.1.4.1.11604.4	user management

Table 1: The OID space utilization within ARC

layer (e.g. grid-manager or gridftp server [4]) or from the local operating system (e.g. information available in the /proc area). Currently, ARC is capable interfacing to the following batch systems (or local resource management system LRMS in the ARC terminology): unix fork, the PBS-family (OpenPBS, PBS-Pro, Torque), Condor and Sun Grid Engine.

The output of the information providers (generated in ldif format) is used to populate the local LDAP tree. A special Openldap back-end, the GLOBUS-GRIS provided by the Globus [3], is used to store the LDIF output of the information providers. This custom Openldap back-end implements two things: it is capable caching the providers output and upon client query request it triggers the information providers unless the data is already available in its cache. The cacheing feature of the Openldap backend provides protection against overloading the local resource by continuously triggering the information providers.

The information stored in the LIT follows the NorduGrid-ARC information model. The next section gives a detailed technical account of the ARC information model.

4 The ARC information model

A Grid information model should be a result of a delicate design process how to represent the resources and what is the best way to structure this information.

ARC implements an LDAP-based information system. In an LDAP-based system the information is being stored as attribute-value pairs grouped together in entries which are organized into a hierarchical tree. Therefore an LDAP-based information model is technically specified via an LDAP schema AND the structure of the LDAP-tree (DIT).

The ARC information model naturally describes the main Grid components:

- computing resources with grid jobs and grid users,
- storage elements
- and metadata catalogues

though the latter two are treated in a rather simplistic manner.

4.1 LDAP technicalities: namespace, OID, objectclasses, attributes

The NorduGrid/ARC LDAP schema (available in appendix ??) makes use of the *nordugrid*- namespace, the objectclass and attribute names starts with the *nordurid*- prefix.

NorduGrid is assigned to the 1.3.6.1.4.1.11604 Private Enterprise Number which is utilized according to the Table1.

The OID's used in the LDAP schema are shown in Table2 and are taken from the range 1.3.6.1.4.1.11604.2.* Table2 also serves as a list of the NorduGrid objectclasses. The ARC implementation follows a "one ldap entry = one objectclass" approach, The ARC information system objects such as grid-enabled clusters, queues, storages, grid users and grid jobs are described by specific ldap entry which utilizes a single objectclass. As a result a one-to-one correspondence exists between ARC ldap entries and ARC objectclasses.

The detailed description of the objectclasses and attributes are given in the following subsections. First the main purpose behind the objectclass is outlined followed by the one-by-one description of the attributes.

1.3.6.1.4.1.11604.2.1.1	cluster objectclass
1.3.6.1.4.1.11604.2.1.1.x	cluster attributes
1.3.6.1.4.1.11604.2.1.2	info-group objectclass
1.3.6.1.4.1.11604.2.1.2.x	info-group attributes
1.3.6.1.4.1.11604.2.1.3	queue objectclass
1.3.6.1.4.1.11604.2.1.3.x	queue attributes
1.3.6.1.4.1.11604.2.1.4	job objectclass
1.3.6.1.4.1.11604.2.1.4.x	job attributes
1.3.6.1.4.1.11604.2.1.5	authuser objectclass
1.3.6.1.4.1.11604.2.1.5.x	authuser attributes
1.3.6.1.4.1.11604.2.1.6	se objectclass
1.3.6.1.4.1.11604.2.1.6.x	se attributes
1.3.6.1.4.1.11604.2.1.7	rc objectclass
1.3.6.1.4.1.11604.2.1.7.x	rc attributes

Table 2: The OIDs from the NorduGrid/ARC schema

The attribute descriptions also contain information about the attribute's role played in the brokering[5], the job submission or the monitoring process. If applicable, the corresponding XRSI attribute[6] is displayed. Please notice that the most of the attribute values documented below are not enforced, missconfigured or rough sites can publish incorrect information.

4.2 The structure of the local ldap tree: Arc DIT

The ARC local ldap tree gives a natural representation of a grid-enabled resource. The *mds-vo-name=local,o=grid* top level entry of the tree carries no information, its role is purely structural. This entry accomodates the subtrees of the different grid services offered by the local machine. A grid resource in ARC can host a computing service and several storage or data indexing services. A computing service is described by the cluster subtree, while the storage and data indexing services are characterised by the *se* and *rc* single-entry subtrees, respectively.



Figure 2: The local information tree on two resources. The first machine bambi.hep.lu.se provides both computing, storage and data indexing services while the second resource hathi.hep.lu.se hosts two storage elements.

Figure 2 shows the local ldap tree of two grid-enabled resources. The first machine bambi.hep.lu.se offers both a computing service, a storage service and a data indexing service, therefore the LIT of bambi.hep.lu.se contains a cluster subtree under the *nordugrid-cluster-name=bambi.hep.lu.se* entry a storage *nordugrid-se-name=..* and a data indexing *nordugrid-rc-name=...* entry. The second resource hathi.hep.lu.se serves as

a dedicated storage hosting two storage elements, therefore the LIT of hathi.hep.lu.se consists of the two storage entries.

The schematic structure of the cluster subtree is shown enlarged in Fig. 3. The *cluster* top entry of the subtree describes the hardware, software and middleware properties of a cluster. Grid-enabled queues are represented by their *queue* entries. Active grid jobs and authorized grid users are described by their corresponding *job* and *authuser* entries which are located under their hosting queues. The *job* and *authuser* entries belonging to the same queue are grouped in two distinct subtrees, the branching is accomplished by structural *nordugrid-info-group=job* and *nordugrid-info-group=user* entries.

The storage and data indexing services are represented by their corresponding single ldap entries, currently no ldap subtree is associated to them.

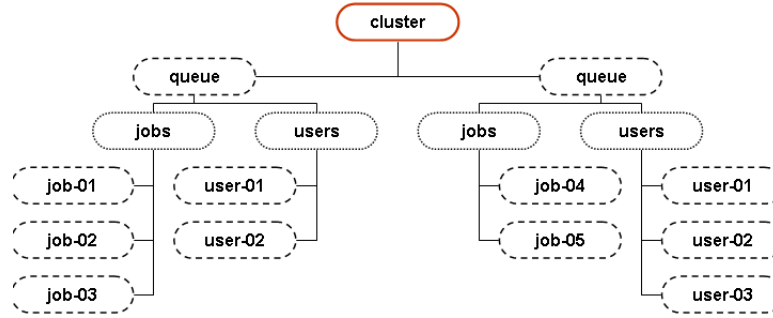


Figure 3: The schematic picture of an LDAP subtree representing a computing resource. The cluster subtree is part of the LIT shown in Fig. 2

4.3 Grouping authuser and job entries: nordugrid-info-group objectclass

The schema contains a special objectclass the *nordugrid-info-group* whose role is to create structural entries in the ldap tree. The entries *nordugrid-info-group=jobs* and *nordugrid-info-group=users* of the LIT are separating nordugrid-job and nordugrid-authuser entries of a grid queue by grouping them in two separate ldap branches under the queue entry (see Fig. 2).

The objectclass comes with a single attribute.

nordugrid-info-group-name

Value: {users,jobs}

Related XRSI: none

The *nordugrid-info-group-name* attribute is used to distinguish between jobs or users grouping: nordugrid-job entries are grouped under the structural entry *nordugrid-info-group-name=jobs* while nordugrid-authuser entries are grouped under the *nordugrid-info-group-name=users* entry.

4.4 Computing resources: nordugrid-cluster and nordugrid-queue objectclass

The nordugrid schema provides two objectclasses for the description of a computing resource. The *nordugrid-cluster* is used to describe general properties such as ownership, name, location, contact URL, pre-installed software environments, grid scratch space, batch system, node properties such as architecture, CPUs, network connectivity. Dynamic cluster load information, such as number of queued/total jobs, is also part of the objectclass information.

The generalized concept of a computing queue plays a central role in ARC: queues are the job submission targets in an ARC-based grid, during the brokering process clients select a grid-enabled queue on a computing resource. An ARC queue represents either a traditional batch queue of a local resource management system (LRMS) such as the PBS or describes an entire LRMS when the LRMS does not support conventional queues

(Condor and SGE is handled this way). The very special LRMS, the unix fork is also described as queue. The *nordugrid-queue* objectclass is designed to describe the generalized concept of a computing queue. Besides the usual queue-specific information (queue status and limits, number of running/queueing jobs) queue-level node attributes are also introduced to describe hardware/software characteristics of computing nodes assigned to a certain queue. Also notice that the schema makes possible the distinction of grid and non-grid jobs being managed by the queue.

The ARC schema introduces cluster- and queue-level node attributes together with two homogeneity attributes in order to handle possible inhomogeneity within a computing resource. The schema is designed to be capable describing inhomogeneous resources with a queue-level homogeneity assumption but higher level inhomogeneity can also be treated with less accuracy.

In case of homogeneous nodes the *nordugrid-cluster-homogeneity=true* is set and the cluster-level node attributes carry the relevant information. If the nodes are inhomogeneous the *nordugrid-cluster-homogeneity=no* is set and the cluster-level node attributes are either not set or their value refers to the smallest/slowest/least powerfull node. Suppose the nodes can be organized into homogeneous subgroups, this case the queue-level node attributes are used to describe the properties of the homogeneous nodes assigned to the same queue. Clients should always treat the queue-level node attributes with higher priority than the cluster-level ones. The *nordugrid-queue-homogeneity=true* attribute value is used to specify the node homogeneity within a queue. The *nordugrid-queue-homogeneity=no* means that if a given queue-level node attribute is set it refers to the smallest/slowest/least powerfull node.

nordugrid-cluster-name

Value: FQDN
 Example: **nordugrid-cluster-name: gate1.monstercluster.nordugrid.org**
 Related XRSL: none
 UI role: ?

Description: The fully qualified domain name of the frontend machine of the cluster. This attribute is used in the Distinguished Name of a cluster ldap entry.

nordugrid-cluster-aliasname

Value: free form text
 Example: **nordugrid-cluster-aliasname: Grid Monster**
 Related XRSL: none
 UI role: ?

Description: A free form text attribute displaying the alias name of the computing resource.

nordugrid-cluster-contactstring

Value: URL
 Example: **nordugrid-cluster-contactstring: gsiftp://bambi.hep.lu.se:2811/jobs**
 Related XRSL: none
 UI role: used during the jobsubmission process

Description: The URL of the job submission service running on the cluster frontend. Clients must use this attribute to determine the URL of the job submission gateway available on the cluster.

nordugrid-cluster-support

Value: RFC822 email address
Example: `nordugrid-cluster-support: help@gridcluster.gridcenter.org`
Related XRSL: none
UI role: none

Description: The support email address of the grid-enabled computing resource, users are suggested to use this address in case they need to contact the site.

nordugrid-cluster-lrms-type

Value: {PBSPro, OpenPBS, torque, SGE,SGEEE, fork, Condor}
Example: `nordugrid-cluster-lrms-type: torque`
Related XRSL: none
UI role: it will be used in the brokering (not implemented yet)

Description: The type of the Local Resource Management System (LRMS) running on the cluster. ARC currently supports the PBS family, the SGE family, the Condor and the unix fork batch systems.

nordugrid-cluster-lrms-version

Value: version string
Example: `nordugrid-cluster-lrms-version: 1.0.1p5`
Related XRSL: none
UI role: none

Description: The vendor specific version string of the Local Resource Management System. The original vendor-provided LRMS version string is displayed without any modification.

nordugrid-cluster-lrms-config

Value: free form text
Example: `Short parallel jobs are prioritised"`
Related XRSL: none
UI role: none

Description: A free form text attribute for additional remarks on the LRMS setup of the cluster. The attribute is purely for 'human consumption'.

nordugrid-cluster-homogeneity

Value: {True, False}
Example: `nordugrid-cluster-homogeneity: False`
Related XRSL: none
UI role: none

Description: A logical flag indicating the homogeneity of the cluster nodes. The frontend is not needed to be homogeneous with the nodes. If the nodes are declared inhomogeneous on the cluster-level, then the the cluster-level node attributes are referring to the properties of the slowest/smallest/least powerfull node.

nordugrid-cluster-architecture

Value: {i686, x86_64, alpha, sun4u}
Example: nordugrid-cluster-architecture: i686
Related XRSL: architecture
UI role: used in the matchmaking/brokering

Description: This is a cluster-level node attribute describing the 'hardware type' of the nodes of the cluster. The 'hardware type' is defined as the output of the `uname -m` unix command.

nordugrid-cluster-opsys

Value: fixed format string
Example: nordugrid-cluster-opsys: Redhat-7.2
Example: nordugrid-cluster-opsys: Linux-2.4.21-mypatch
Example: nordugrid-cluster-opsys: glibc-2.3.1
Related XRSL: none
UI role: not yet used in the brokering

Description: The multivalued cluster-level node attribute is meant to describe the operating system of the computing nodes. The attribute describes the operating system via the specification of the software distribution. The same multivalued attribute is also used to specify the kernel or libc version in case those differ from the originally shipped ones. The attribute value follows a *fixed form syntax*: the distribution name is given as `distroname-version.number` where spaces are not allowed. *Kernel* and *libc* versions are specified according to a fixed form: `kernelname-version.number, libcname-version.number`.

nordugrid-cluster-nodectpu

Value: fixed format string
Example: nordugrid-cluster-nodectpu: Dual AMD Athlon(tm) MP Processor 1800+ @ 1500 MHz
Related XRSL: gridTime
UI role: used in the brokering process

Description: This cluster-level node attribute gives the cputype information of the cluster nodes in a fixed format. The string is constructed as `CPU-model-name CPU-frequency MHZ`, where CPU-model-name and CPU-frequency are vendor specified values (on Linux systems the data is taken from the `/proc/cpuinfo`).

nordugrid-cluster-nodememory

Value: a number showing the amount in MBs
Example: nordugrid-cluster-nodememory: 900
Related XRSL: memory
UI role: used in the matchmaking/brokering

Description: The amount of node memory in MBs which can be guaranteed to be available for the application running on the node. Please note in most cases it is less than the physical memory installed in the nodes.

nordugrid-cluster-totalcpus

Value:

Related XRSL:

Description:

nordugrid-cluster-cpudistribution

Value:

Related XRSL:

Description:

nordugrid-cluster-sessiondir-free

Value:

Related XRSL:

Description:

nordugrid-cluster-sessiondir-total

Value:

Related XRSL:

Description:

nordugrid-cluster-cache-free

Value:

Related XRSL:

Description:

nordugrid-cluster-cache-total

Value:

Related XRSL:

Description:

nordugrid-cluster-runtimeenvironment

Value:

Related XRSL:

Description:

nordugrid-cluster-locale

Value:

Related XRSL:

Description:

nordugrid-cluster-middleware

Value:

Related XRSL:

Description:

nordugrid-cluster-totaljobs

Value:

Related XRSL:

Description:

nordugrid-cluster-usedcpus

Value:

Related XRSL:

Description:

nordugrid-cluster-queuedjobs

Value:

Related XRSL:

Description:

nordugrid-cluster-location

Value:

Related XRSL:

Description:

nordugrid-cluster-owner

Value:

Related XRSL:

Description:

nordugrid-cluster-issuerca

Value:

Related XRSL:

Description:

nordugrid-cluster-nodeaccess

Value:

Related XRSL:

Description:

nordugrid-cluster-comment

Value:

Related XRSL:

Description:

nordugrid-cluster-interactive-contactstring

Value:

Related XRSL:

Description:

nordugrid-cluster-benchmark

Value:

Related XRSL:

Description:

nordugrid-queue-name

Value:

Related XRSL:

Description:

nordugrid-queue-status

Value:

Related XRSL:

Description:

nordugrid-queue-running

Value:

Related XRSL:

Description:

nordugrid-queue-queued

Value:

Related XRSL:

Description:

nordugrid-queue-maxrunning

Value:

Related XRSL:

Description:

nordugrid-queue-maxqueueable

Value:

Related XRSL:

Description:

nordugrid-queue-maxuserrun

Value:

Related XRSL:

Description:

nordugrid-queue-maxcputime

Value:

Related XRSL:

Description:

nordugrid-queue-mincputime

Value:

Related XRSL:

Description:

nordugrid-queue-defaultcputime

Value:

Related XRSL:

Description:

nordugrid-queue-schedulingpolicy

Value:

Related XRSL:

Description:

nordugrid-queue-totalcpus

Value:

Related XRSL:

Description:

nordugrid-queue-nodecpu

Value:

Related XRSL:

Description:

nordugrid-queue-nodememory

Value:

Related XRSL:

Description:

nordugrid-queue-architecture

Value:

Related XRSL:

Description:

nordugrid-queue-opsys

Value:

Related XRSL:

Description:

nordugrid-queue-gridrunning

Value:

Related XRSL:

Description:

nordugrid-queue-gridqueued

Value:

Related XRSL:

Description:

nordugrid-queue-comment

Value:

Related XRSL:

Description:

nordugrid-queue-benchmark

Value:

Related XRSL:

Description:

nordugrid-queue-homogeneity

Value:

Related XRSL:

Description:

4.5 Grid jobs: nordugrid-job objectclass

Every Grid job submitted to the grid-enabled resource is represented by a *job* entry. The job entries are generated on the execution cluster, this way implementing a distributed job status monitoring system.

nordugrid-job-globalid

Value:

Related XRSL:

Description:

nordugrid-job-globalowner

Value:

Related XRSL:

Description:

nordugrid-job-execcluster

Value:

Related XRSL:

Description:

nordugrid-job-execqueue

Value:

Related XRSL:

Description:

nordugrid-job-stdout

Value:

Related XRSL:

Description:

nordugrid-job-stderr

Value:

Related XRSL:

Description:

nordugrid-job-stdin

Value:

Related XRSL:

Description:

nordugrid-job-reqcput

Value:

Related XRSL:

Description:

nordugrid-job-status

Value:

Related XRSL:

Description:

nordugrid-job-queuerank

Value:

Related XRSL:

Description:

nordugrid-job-lrmscomment

Value:

Related XRSL:

Description:

nordugrid-job-submissionui

Value:

Related XRSL:

Description:

nordugrid-job-submissiontime

Value:

Related XRSL:

Description:

nordugrid-job-usedcputime

Value:

Related XRSL:

Description:

nordugrid-job-usedwalltime

Value:

Related XRSL:

Description:

nordugrid-job-sessiondirerasetime

Value:

Related XRSL:

Description:

nordugrid-job-usedmem

Value:

Related XRSL:

Description:

nordugrid-job-errors

Value:

Related XRSL:

Description:

nordugrid-job-jobname

Value:

Related XRSL:

Description:

nordugrid-job-runtimeenvironment

Value:

Related XRSL:

Description:

nordugrid-job-cpucount

Value:

Related XRSL:

Description:

nordugrid-job-executionnodes

Value:

Related XRSL:

Description:

nordugrid-job-gmlog

Value:

Related XRSL:

Description:

nordugrid-job-clientsoftware

Value:

Related XRSL:

Description:

nordugrid-job-proxyexpirationtime

Value:

Related XRSL:

Description:

nordugrid-job-completiontime

Value:

Related XRSL:

Description:

nordugrid-job-exitcode

Value:

Related XRSL:

Description:

4.6 Grid users: nordugrid-authuser objectclass

Every authorized Grid user possesses an *authuser* entry containing user-based information such as free CPUs and available disk space. The nordugrid-authuser objectclass

nordugrid-authuser-name

Value:

Related XRSL:

Description:

nordugrid-authuser-sn

Value:

Related XRSL:

Description:

nordugrid-authuser-freecpus

Value:

Related XRSL:

Description:

nordugrid-authuser-diskspace

Value:

Related XRSL:

Description:

nordugrid-authuser-queuelength

Value:

Related XRSL:

Description:

4.7 Storages and Data catalogues: nordugrid-se and nordugrid-rc objectclasses

These objectclasses are very preliminary, a major revision is needed.

nordugrid-se-name

Value:

Related XRSL:

Description:

nordugrid-se-aliasname

Value:

Related XRSL:

Description:

nordugrid-se-type

Value:

Related XRSL:

Description:

nordugrid-se-freespace

Value:

Related XRSL:

Description:

nordugrid-se-baseurl

Value:

Related XRSL:

Description:

nordugrid-se-authuser

Value:

Related XRSL:

Description:

nordugrid-se-location

Value:

Related XRSL:

Description:

nordugrid-se-owner

Value:

Related XRSL:

Description:

nordugrid-se-issuerca

Value:

Related XRSL:

Description:

nordugrid-se-totalspace

Value:

Related XRSL:

Description:

nordugrid-se-middleware

Value:

Related XRSL:

Description:

nordugrid-se-comment

Value:

Related XRSL:

Description:

nordugrid-rc-name

Value:

Related XRSL:

Description:

nordugrid-rc-aliasname

Value:

Related XRSL:

Description:

nordugrid-rc-baseurl

Value:

Related XRSL:

Description:

nordugrid-rc-authuser

Value:

Related XRSL:

Description:

nordugrid-rc-location

Value:

Related XRSL:

Description:

nordugrid-rc-owner

Value:

Related XRSL:

Description:

nordugrid-rc-issuerca

Value:

Related XRSL:

Description:

Value:

Related XRSL:

Description:

4.8 Confidentiality

5 Information Indices, Registration Process, Topology

6 Resource discovery

7 Clients

Appendix A: NorduGrid LDAP schema file

```
# attributes for the nordugrid-cluster objectclass
#
attributetype ( 1.3.6.1.4.1.11604.2.1.1.1
    NAME 'nordugrid-cluster-name'
    DESC 'The name of the cluster specified as the domain name of the frontend'
    EQUALITY caseIgnoreMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.2
    NAME 'nordugrid-cluster-aliasname'
    DESC 'The alias name of the cluster'
    EQUALITY caseIgnoreMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.3
    NAME 'nordugrid-cluster-contactstring'
    DESC 'The URL of the job submission service running on the cluster frontend'
    EQUALITY caseExactIA5Match
    SUBSTR caseExactIA5SubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.4
    NAME 'nordugrid-cluster-support'
    DESC 'RFC822 email address of support'
    EQUALITY caseIgnoreIA5Match
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.26{256})

attributetype ( 1.3.6.1.4.1.11604.2.1.1.5
    NAME 'nordugrid-cluster-lrms-type'
    DESC 'The type of the Local Resource Management System'
    EQUALITY caseIgnoreMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.6
    NAME 'nordugrid-cluster-lrms-version'
    DESC 'The version of the Local Resource Management System'
    EQUALITY caseIgnoreMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.7
    NAME 'nordugrid-cluster-lrms-config'
    DESC 'Additional remark on the LRMS config'
    EQUALITY caseIgnoreMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.8
    NAME 'nordugrid-cluster-architecture'
    DESC 'The architecture of the cluster nodes'
    EQUALITY caseIgnoreMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.9
    NAME 'nordugrid-cluster-opsys'
    DESC 'The operating system of the machines of the cluster'
    EQUALITY caseIgnoreMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.44)

attributetype ( 1.3.6.1.4.1.11604.2.1.1.10
    NAME 'nordugrid-cluster-homogeneity'
    DESC 'A logical flag indicating the homogeneity of the cluster nodes'
    EQUALITY caseIgnoreMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.7
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.11
    NAME 'nordugrid-cluster-nodescpu'
    DESC 'The cpu type of the nodes expressed in a fixed form (model name + MHz)'
    EQUALITY integerMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.12
    NAME 'nordugrid-cluster-nodememory'
    DESC 'The amount of memory which can be guaranteed to be available on node in MB'
    EQUALITY integerMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
    SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.13
    NAME 'nordugrid-cluster-totalcpus'
    DESC 'The total number of cpus in the cluster'
    EQUALITY integerMatch
    ORDERING caseIgnoreOrderingMatch
    SUBSTR caseIgnoreSubstringsMatch
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
    SINGLE-VALUE )
```

```

attributetype ( 1.3.6.1.4.1.11604.2.1.1.14
  NAME 'nordugrid-cluster-cpudistribution'
  DESC 'The cpu distribution of the nodes given in the form of 1cpu:3 2cpu:4 4cpu:1'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.15
  NAME 'nordugrid-cluster-sessiondir-free'
  DESC 'Free disk space in MB of the sessiondirectory on the cluster'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.16
  NAME 'nordugrid-cluster-sessiondir-total'
  DESC 'Total disk space in MB of the sessiondirectory on the cluster'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.17
  NAME 'nordugrid-cluster-cache-free'
  DESC 'Free disk space in MB of the cache area on the cluster'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.18
  NAME 'nordugrid-cluster-cache-total'
  DESC 'Total disk space in MB of the cache area on the cluster'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.19
  NAME 'nordugrid-cluster-runtimeenvironment'
  DESC 'preinstalled software packages of the cluster'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.20
  NAME 'nordugrid-cluster-locale'
  DESC 'The URL of a storage element considered to be local to the cluster'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.21
  NAME 'nordugrid-cluster-middleware'
  DESC 'The middleware packages on the cluster'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.22
  NAME 'nordugrid-cluster-totaljobs'
  DESC 'The total number of jobs (Grid + non-Grid) in the cluster'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.23
  NAME 'nordugrid-cluster-usedcpus'
  DESC 'The total number of occupied cpus in the cluster'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.24
  NAME 'nordugrid-cluster-queuedjobs'
  DESC 'The total number of jobs being queued on the cluster, either in the gridmanager or in the
    LRMS'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.25
  NAME 'nordugrid-cluster-location'
  DESC 'The geographical location of the cluster expressed in terms of a Postal ZIP code'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.26
  NAME 'nordugrid-cluster-owner'
  DESC 'The owner of the resource'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.27
  NAME 'nordugrid-cluster-issuerca'

```

```

DESC 'The DN of the Certificate Authority which issued the certificate of the cluster'
EQUALITY caseExactMatch
ORDERING caseExactOrderingMatch
SUBSTR caseExactSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.28
  NAME 'nordugrid-cluster-nodeaccess'
  DESC 'The inbound/outbound network accessibility of the nodes'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.29
  NAME 'nordugrid-cluster-comment'
  DESC 'Free form comment'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44{256}
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.30
  NAME 'nordugrid-cluster-interactive-contactstring'
  DESC 'The cluster contact string for interactive login'
  EQUALITY caseExactIA5Match
  SUBSTR caseExactIA5SubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.26 )

attributetype ( 1.3.6.1.4.1.11604.2.1.1.31
  NAME 'nordugrid-cluster-benchmark'
  DESC '@ separated benchmark_name, benchmark_value pair characterizing the cluster'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

objectclass ( 1.3.6.1.4.1.11604.2.1.1
  NAME 'nordugrid-cluster'
  DESC 'Description of a Nordugrid cluster'
  SUP 'Mds'
  STRUCTURAL
  MUST ( nordugrid-cluster-name $ nordugrid-cluster-contactstring )
  MAY ( nordugrid-cluster-aliasname $ nordugrid-cluster-support $
    nordugrid-cluster-lrms-type $ nordugrid-cluster-lrms-version $
    nordugrid-cluster-lrms-config $ nordugrid-cluster-architecture $
    nordugrid-cluster-opsys $ nordugrid-cluster-homogeneity $
    nordugrid-cluster-nodescpu $ nordugrid-cluster-nodememory $
    nordugrid-cluster-totalcpus $ nordugrid-cluster-cpudistribution $
    nordugrid-cluster-sessiondir-free $ nordugrid-cluster-sessiondir-total $
    nordugrid-cluster-cache-free $ nordugrid-cluster-cache-total $
    nordugrid-cluster-runtimeenvironment $ nordugrid-cluster-locale $
    nordugrid-cluster-middleware $ nordugrid-cluster-totaljobs $
    nordugrid-cluster-usedcpus $ nordugrid-cluster-queuedjobs $
    nordugrid-cluster-location $ nordugrid-cluster-owner $
    nordugrid-cluster-issuerca $ nordugrid-cluster-nodeaccess $
    nordugrid-cluster-comment $ nordugrid-cluster-interactive-contactstring $
    nordugrid-cluster-benchmark ) )

#-----
# attributes for the nordugrid-info-group objectclass
#
attributetype ( 1.3.6.1.4.1.11604.2.1.2.1
  NAME 'nordugrid-info-group-name'
  DESC 'Locally unique info group name'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

objectclass ( 1.3.6.1.4.1.11604.2.1.2
  NAME 'nordugrid-info-group'
  DESC 'A general entry for grouping together MDS entries'
  SUP 'Mds'
  STRUCTURAL
  MUST ( nordugrid-info-group-name ) )

#-----
# attributes for the nordugrid-queue objectclass
#
attributetype ( 1.3.6.1.4.1.11604.2.1.3.1
  NAME 'nordugrid-queue-name'
  DESC 'The queue name'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.2
  NAME 'nordugrid-queue-status'
  DESC 'The queue status'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.3
  NAME 'nordugrid-queue-running'
  DESC 'Number of running jobs (Grid + non-Grid) in the queue with multi-node jobs multiplicity'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.4
  NAME 'nordugrid-queue-queued'
  DESC 'The number of jobs (Grid + non-Grid) waiting in the queue'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch

```

```

SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.5
  NAME 'nordugrid-queue-maxrunning'
  DESC 'The maximum number of jobs allowed to run from this queue'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.6
  NAME 'nordugrid-queue-maxqueueable'
  DESC 'The maximum number of jobs allowed to reside in the queue'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.7
  NAME 'nordugrid-queue-maxuserun'
  DESC 'Maximum number of jobs a user can run at the same time'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.8
  NAME 'nordugrid-queue-maxcputime'
  DESC 'The maximum cputime allowed in this queue (in minutes)'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.9
  NAME 'nordugrid-queue-mincputime'
  DESC 'The minimum possible cputime of this queue (in minutes)'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.10
  NAME 'nordugrid-queue-defaultcputime'
  DESC 'The default cputime assigned to this queue (in minutes)'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.11
  NAME 'nordugrid-queue-schedulingpolicy'
  DESC 'The scheduling policy of the queue (i.e. FIFO)'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.12
  NAME 'nordugrid-queue-totalcpus'
  DESC 'Total number of cpus assigned to the queue'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.13
  NAME 'nordugrid-queue-nodectpu'
  DESC 'The cpu type of the nodes assigned to the queue (model name + MHz)'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.14
  NAME 'nordugrid-queue-nodememory'
  DESC 'The installed memory of a node assigned to the queue in MB'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.15
  NAME 'nordugrid-queue-architecture'
  DESC 'The architecture of the machines in the queue'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.16
  NAME 'nordugrid-queue-opsys'
  DESC 'The operating system of the nodes in the queue'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.17
  NAME 'nordugrid-queue-gridrunning'
  DESC 'Number of running Grid jobs in the queue with multi-node jobs multiplicity'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch

```

```

SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.18
  NAME 'nordugrid-queue-gridqueued'
  DESC 'The number of Grid jobs waiting in the queue'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.19
  NAME 'nordugrid-queue-comment'
  DESC 'Free form comment'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44{256}
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.20
  NAME 'nordugrid-queue-benchmark'
  DESC 'Colon separated benchmark_name, benchmark_value pair characterizing the queue'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.3.21
  NAME 'nordugrid-queue-homogeneity'
  DESC 'A logical flag indicating the homogeneity of the queue nodes'
  EQUALITY caseIgnoreMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.7
  SINGLE-VALUE )

objectclass ( 1.3.6.1.4.1.11604.2.1.3
  NAME 'nordugrid-queue'
  DESC 'An LRMS queue'
  SUP 'Mds'
  STRUCTURAL
  MUST ( nordugrid-queue-name $ nordugrid-queue-status )
  MAY ( nordugrid-queue-running $ nordugrid-queue-queued $
        nordugrid-queue-maxrunning $ nordugrid-queue-maxqueueable $
        nordugrid-queue-maxuserun $ nordugrid-queue-maxcputime $
        nordugrid-queue-mincputime $ nordugrid-queue-defaultcputime $
        nordugrid-queue-schedulingpolicy $ nordugrid-queue-totalcpus $
        nordugrid-queue-nodecpu $ nordugrid-queue-nodememory $
        nordugrid-queue-opsys $ nordugrid-queue-architecture $
        nordugrid-queue-gridrunning $ nordugrid-queue-gridqueued $
        nordugrid-queue-comment $ nordugrid-queue-benchmark $
        nordugrid-queue-homogeneity ) )

#-----
#Attributes for the nordugrid-job objectclass
#
attributetype ( 1.3.6.1.4.1.11604.2.1.4.1
  NAME 'nordugrid-job-globalid'
  DESC 'The global job identifier string'
  EQUALITY caseExactIA5Match
  SUBSTR caseExactIA5SubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.2
  NAME 'nordugrid-job-globalowner'
  DESC 'The SubjectName of the job owner'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.3
  NAME 'nordugrid-job-execcluster'
  DESC 'The name of the execution cluster'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.4
  NAME 'nordugrid-job-execqueue'
  DESC 'The name of the execution queue'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.5
  NAME 'nordugrid-job-stdout'
  DESC 'The name of the file which contains the stdout'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.6
  NAME 'nordugrid-job-stderr'
  DESC 'The name of the file which contains the stderr'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.7
  NAME 'nordugrid-job-stdin'
  DESC 'The name of the file which contains the stdin'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch

```

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SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.8
  NAME 'nordugrid-job-reqcput'
  DESC 'The cputime request of the job in minutes'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.9
  NAME 'nordugrid-job-status'
  DESC 'The status of the grid job'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.10
  NAME 'nordugrid-job-queuerank'
  DESC 'The queue position of the job'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.11
  NAME 'nordugrid-job-lrmscomment'
  DESC 'The jobcomment of the LRMS'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.12
  NAME 'nordugrid-job-submissionui'
  DESC 'The name of the UI from where the job was submitted'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.13
  NAME 'nordugrid-job-submissiontime'
  DESC 'The submission time of the job in GMT'
  EQUALITY generalizedTimeMatch
  ORDERING generalizedTimeOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.24
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.14
  NAME 'nordugrid-job-usedcputime'
  DESC 'The consumed cputime of the job in minutes'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.15
  NAME 'nordugrid-job-usedwalltime'
  DESC 'The consumed walltime of the job in minutes'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.16
  NAME 'nordugrid-job-sessiondirerasetime'
  DESC 'The date when the session dir will be deleted in GMT'
  EQUALITY generalizedTimeMatch
  ORDERING generalizedTimeOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.24
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.17
  NAME 'nordugrid-job-usedmem'
  DESC 'The memory usage of the job (in KB)'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.18
  NAME 'nordugrid-job-errors'
  DESC 'Error messages from the cluster'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.19
  NAME 'nordugrid-job-jobname'
  DESC 'The jobname specified by the user with the jobname RSL attribute'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.20
  NAME 'nordugrid-job-runtimeenvironment'
  DESC 'The runtimeenvironment requested by the job'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch

```

```

SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.21
  NAME 'nordugrid-job-cpucount'
  DESC 'The number of CPUs requested by the job'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.22
  NAME 'nordugrid-job-executionnodes'
  DESC 'The list of nodenames where the job is running'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.23
  NAME 'nordugrid-job-gmlog'
  DESC 'The name of the directory which contains the grid session related logs'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.24
  NAME 'nordugrid-job-clientsoftware'
  DESC 'The client software which submitted the job'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44)

attributetype ( 1.3.6.1.4.1.11604.2.1.4.25
  NAME 'nordugrid-job-proxyexpirationtime'
  DESC 'The expiration time of the proxy of the job in GMT'
  EQUALITY generalizedTimeMatch
  ORDERING generalizedTimeOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.24
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.26
  NAME 'nordugrid-job-completiontime'
  DESC 'The completion time of the grid job in GMT'
  EQUALITY generalizedTimeMatch
  ORDERING generalizedTimeOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.24
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.4.27
  NAME 'nordugrid-job-exitcode'
  DESC 'The exit code of the executable of the job obtained from the LRMS'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

objectclass ( 1.3.6.1.4.1.11604.2.1.4
  NAME 'NorduGrid-job'
  DESC 'A Grid job'
  SUP 'Mds'
  STRUCTURAL
  MUST ( nordugrid-job-globalid $ nordugrid-job-globalowner $
    nordugrid-job-status )
  MAY ( nordugrid-job-queuerank $ nordugrid-job-submissionui $
    nordugrid-job-submissiontime $
    nordugrid-job-usedcputime $ nordugrid-job-usedwalltime $
    nordugrid-job-usedmem $ nordugrid-job-lrmscomment $
    nordugrid-job-execcluster $ nordugrid-job-execqueue $
    nordugrid-job-stdout $ nordugrid-job-stderr $
    nordugrid-job-stdin $
    nordugrid-job-sessiondirerasetime $ nordugrid-job-reqcpuct $
    nordugrid-job-errors $ nordugrid-job-jobname $
    nordugrid-job-runtimeenvironment $ nordugrid-job-cpuaccount $
    nordugrid-job-executionnodes $ nordugrid-job-gmlog $
    nordugrid-job-clientsoftware $ nordugrid-job-proxyexpirationtime $
    nordugrid-job-completiontime $ nordugrid-job-exitcode ))

#-----
# attributes for the nordugrid-authuser objectclass
#

# attributetype ( 1.3.6.1.4.1.11604.2.1.5.1
#   NAME 'nordugrid-authuser-sn'
#   DESC 'The SubjectName of the authorized user'
#   EQUALITY distinguishedNameMatch
#   ORDERING caseIgnoreOrderingMatch
#   SYNTAX 1.3.6.1.4.1.1466.115.121.1.12
#   SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.5.1
  NAME 'nordugrid-authuser-name'
  DESC 'The Common Name of the authorized user plus a local unique number'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.5.2
  NAME 'nordugrid-authuser-sn'
  DESC 'The SubjectName of the authorized user'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.5.3

```

```

NAME 'nordugrid-authuser-freecpus'
DESC 'The number of freely available cpus with their timelimits in minutes
      for a user in the queue. Given in the form ncpus:min,
min is optional (example: 2 4:25 5:180)'
EQUALITY caseIgnoreMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.5.4
NAME 'nordugrid-authuser-diskspace'
DESC 'The free disk space available for the job (in MB)'
EQUALITY integerMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.5.5
NAME 'nordugrid-authuser-queuelength'
DESC 'The queuelength experienced by the user due to its local unix mapping'
EQUALITY integerMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
SINGLE-VALUE )

objectclass ( 1.3.6.1.4.1.11604.2.1.5
NAME 'nordugrid-authuser'
DESC 'An authorised user of a NorduGrid cluster'
SUP 'Mds'
STRUCTURAL
MUST ( nordugrid-authuser-name $ nordugrid-authuser-sn )
MAY ( nordugrid-authuser-queuelength $ nordugrid-authuser-diskspace $
      nordugrid-authuser-freecpus )

#-----
#
# nordugrid-se

attributetype ( 1.3.6.1.4.1.11604.2.1.6.1
NAME 'nordugrid-se-name'
DESC 'The name of the Storage Element'
EQUALITY caseIgnoreMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.2
NAME 'nordugrid-se-aliasname'
DESC 'The alias name of the SE'
EQUALITY caseIgnoreMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.3
NAME 'nordugrid-se-type'
DESC 'The type of the SE'
EQUALITY caseIgnoreMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.4
NAME 'nordugrid-se-freespace'
DESC 'The free space available in the SE (in MB)'
EQUALITY integerMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.5
NAME 'nordugrid-se-baseurl'
DESC 'The URL to contact the Storage Element'
EQUALITY caseIgnoreMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.6
NAME 'nordugrid-se-authuser'
DESC 'The DN of an authorized user'
EQUALITY caseExactMatch
ORDERING caseExactOrderingMatch
SUBSTR caseExactSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.7
NAME 'nordugrid-se-location'
DESC 'The geographical location of the SE expressed in terms of a Postal ZIP code: SE-22363'
EQUALITY caseIgnoreMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.8
NAME 'nordugrid-se-owner'
DESC 'The owner of the resource'
EQUALITY caseIgnoreMatch
ORDERING caseIgnoreOrderingMatch
SUBSTR caseIgnoreSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.9
NAME 'nordugrid-se-issuerca'
DESC 'The DN of the Certificate Authority which issued the certificate of the SE'
EQUALITY caseExactMatch
ORDERING caseExactOrderingMatch

```

```

SUBSTR caseExactSubstringsMatch
SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.10
  NAME 'nordugrid-se-totalspace'
  DESC 'The total capacity of the SE (in MB)'
  EQUALITY integerMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.27
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.11
  NAME 'nordugrid-se-middleware'
  DESC 'The middleware packages on the SE'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.6.12
  NAME 'nordugrid-se-comment'
  DESC 'Free form comment'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44{256}
  SINGLE-VALUE )

objectclass ( 1.3.6.1.4.1.11604.2.1.6
  NAME 'nordugrid-se'
  DESC 'A storage element in the Nordugrid'
  SUP 'Mds'
  STRUCTURAL
  MUST ( nordugrid-se-name $ nordugrid-se-baseurl )
  MAY ( nordugrid-se-aliasname $ nordugrid-se-type $
        nordugrid-se-freespace $ nordugrid-se-authuser $
        nordugrid-se-location $ nordugrid-se-owner $
        nordugrid-se-issuerca $ nordugrid-se-totalspace $
        nordugrid-se-middleware $ nordugrid-se-comment ) )

#-----
# nordugrid-rc
#
attributetype ( 1.3.6.1.4.1.11604.2.1.7.1
  NAME 'nordugrid-rc-name'
  DESC 'The domain name of the machine hosting the Replica Catalog'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.7.2
  NAME 'nordugrid-rc-aliasname'
  DESC 'The alias name of the rc'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.7.3
  NAME 'nordugrid-rc-baseurl'
  DESC 'The URL of the Replica Catalog'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44
  SINGLE-VALUE )

attributetype ( 1.3.6.1.4.1.11604.2.1.7.4
  NAME 'nordugrid-rc-authuser'
  DESC 'An authorized user of the replica catalog'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.7.5
  NAME 'nordugrid-rc-location'
  DESC 'The geographical location of the RC expressed in terms of a Postal ZIP code'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.7.6
  NAME 'nordugrid-rc-owner'
  DESC 'The owner of the resource'
  EQUALITY caseIgnoreMatch
  ORDERING caseIgnoreOrderingMatch
  SUBSTR caseIgnoreSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

attributetype ( 1.3.6.1.4.1.11604.2.1.7.7
  NAME 'nordugrid-rc-issuerca'
  DESC 'The DN of the Certificate Authority which issued the certificate of the RC'
  EQUALITY caseExactMatch
  ORDERING caseExactOrderingMatch
  SUBSTR caseExactSubstringsMatch
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.44 )

objectclass ( 1.3.6.1.4.1.11604.2.1.7
  NAME 'nordugrid-rc'
  DESC 'A replica catalogue in the Nordugrid'
  SUP 'Mds'
  STRUCTURAL
  MUST ( nordugrid-rc-name $ nordugrid-rc-baseurl )
  MAY ( nordugrid-rc-aliasname $ nordugrid-rc-authuser $
        nordugrid-rc-location $ nordugrid-rc-owner $
        nordugrid-rc-issuerca ) )

```

Appendix B: LDAP Examples

example ldap query for local information, example ldap query of a resource index for available resources, etc..

References

- [1] NorduGrid project. <http://www.nordugrid.org>
- [2] Openldap. <http://www.openldap.org>
- [3] Monitoring and Discovery Services. <http://www.globus.org/mds/mds2/>
- [4] The NorduGrid Grid Manager And GridFTP Server: Description And Administrator's Manual. <http://www.nordugrid.org/papers.html>
- [5] The NorduGrid Brokering Algorithm, M.Ellert, <http://www.nordugrid.org/papers.html>
- [6] XRSI (Extended Resource Specification Language), O.Smirnova, <http://www.nordugrid.org/papers.html>