Sun Grid Engine, a new scheduler for EGEE

G. Borges, M. David, J. Gomes, J. Lopez, P. Rey, A. Simon, C. Fernandez, D. Kant, K. M. Sephton

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Outline

- **EGEE back to basics**
  - The EGEE project
    - The Infrastructure and the gLite Middleware
- **EGEE Local Resource Management Systems (LRMS)**
  - LSF, Torque/Maui, Condor and Sun Grid Engine
- **Sun Grid Engine gLite integration (for the lcg-CE)**
  - JobManager
  - Accounting Information
  - Information plug-in
  - YAIM Integration
- **Conclusions and Future Work**

EGEE Project

- **Enabling Grids for E-Science fundamental goal**
  - Deployment of a **Grid Infrastructure for all fields of science**
- **EGEE infrastructure**
  - Resources are “glued” together by a set of agreed services provided and supported by the EGEE comunity
  - EGEE proposes gLite as the appropriate middleware to support the necessary grid services for multi-science aplications
- **EGEE Services are divided in two different sets:**
  - Core Services: Only installed in some RCs but used by all users
    - Resource Broker, Top-BDII, File Catalogues, VOMS servers,...
  - Local Services: Deployed and Maintained by each participating site
    - **Computing Element**, Storage Element, MonBox, User Interface,...

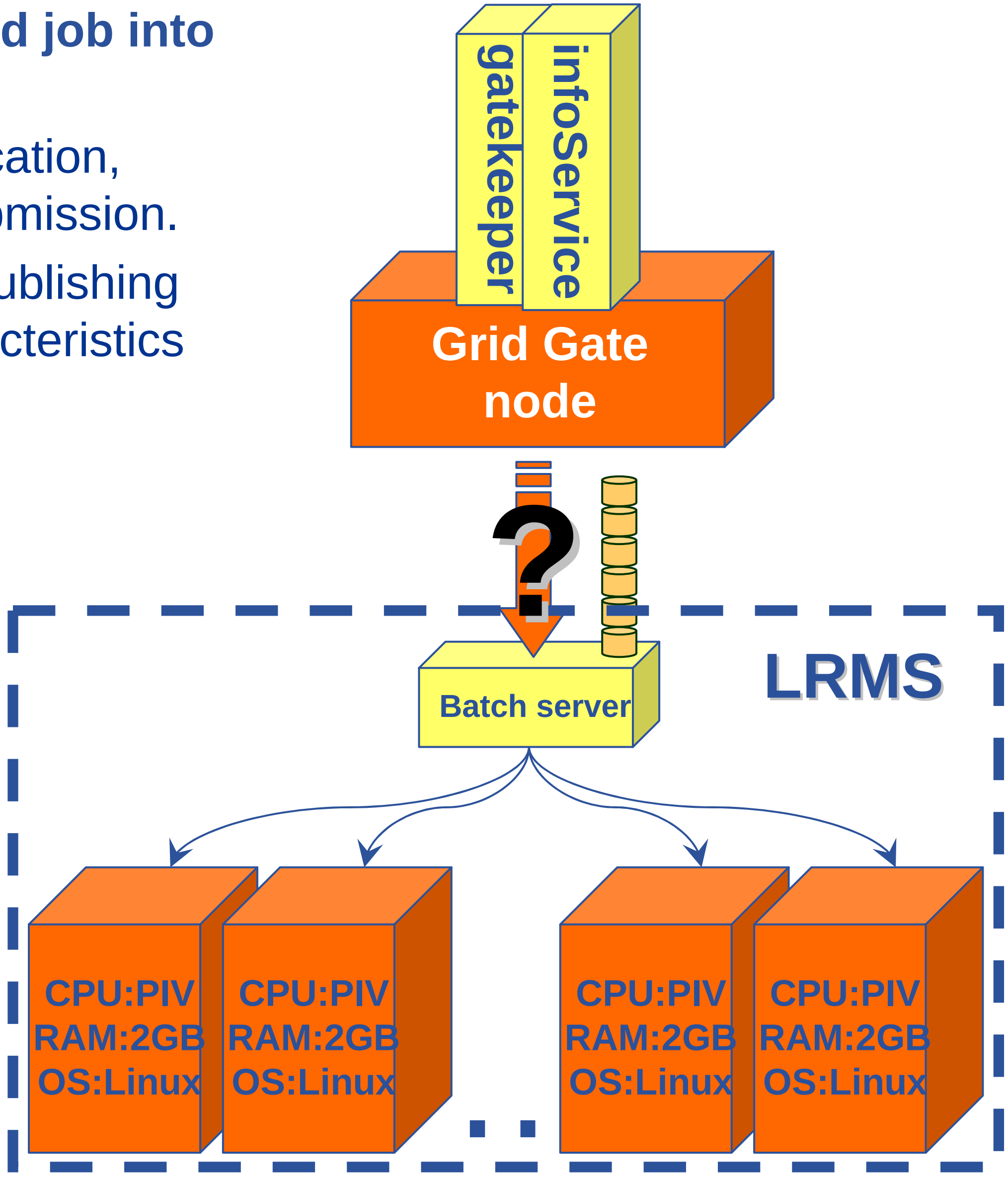
The Computing Element

- **The CE may be used by a generic client**
  - An end-user which interacts directly with it
  - The Workload Manager (RB) which submits a given job to it after going through by all the matchmaking process
- **It is THE SERVICE representing the computing resources**
  - Authentication and Autorization
  - Has to interact with the **Local Resource Management System**
    - **Job management (Job submission, Job control, Job canceling,...)**
    - **Provide information describing itself**
      - *This information is published in the Information Service*
      - *Used by the match making engine which matches available resources to queued jobs.*

Computing Element and the LRMS

- The CE is the **entry point** from a Grid job into the LRMS
  - **Gatekeeper Service** for Authentication, Authorization and Globus Job Submission.
  - **GRIS Service (InfoService)** for publishing Local Resource Usage and Characteristics

- gLite must implement proper tools (Virtual Layers) to
  - **Use LRMS specific cmds for**
    - Job Management (translate RSL requests; feed the L&B Service)
    - Query Resource Usage (feed the CE GRIS Service)
  - Process the **Accounting Information** generated by the LRMS and feed it to the central Accounting Registry



LRMS

- **The Local Resource Management System (LRMS) is the Cluster Component which**
  - Manages the execution of Users Applications
  - Allows to optimize the Cluster Resource Usage
  - Enables to fullfil a broadrage of Usage Policies
  - Easies the Cluster Administration Tasks

- **Each EGEE Cluster Admin should be allowed to choose the LRMS he thinks its best for their needs**
  - Most of the times, EGEE clusters are shared with Local Farms
  - However, only Torque/Maui and LSF are fully supported in EGEE

- **gLite should be able to cope with a much wider set of LRMS**
  - Easies the integration of clusters already in operation
  - Better inter-operability
  - The wider the gLite offer, more appealing it becomes…

Basic LRMS Comparison

LRMS	Pros	Cons
LSF	- Flexible Job Scheduling Policies - Advance Resource Management ○ Checkpointing & Job Migration, Load Balacing - Good Graphical Interfaces to monitor Cluster functionalities - Integrable with Grids	- Expensive comercial product - Not suitable for small computing clusters
Torque/ Maui	- Good integration of parallel libraries ○ Able to start parallel jobs using LRMS services ○ Full control of parallel processes - Flexible Job Scheduling Policies ○ Fair Share Policies, Backfilling, Resource Reservations	- Configurations done through the command line - A non user friendly GUI - Software development uncertain - Bad documentation
Condor	- CPU harvesting - Special ClassAds language - Dynamic check-pointing and migration - Mechanisms for Globus Interface - Coherent with gLite MD	- Not optimal to parallel aplications - Check-pointing only works for batch jobs - Complex configuration

Sun Grid Engine

- **SGE, an open source job management system supported by Sun**
  - Queues are located in server nodes and have attributes which caracterize the properties of the different servers
    - A user may request at submission time certain **execution features**
      - *Memory, execution speed, available software licences, etc*
    - Submitted jobs wait in a holding area where its requirements/priorities are determined
      - *It only runs if there are queues (servers) matching the job requests*

- **Some Important Features**
  - Supports **Check-pointing and Migration...**
    - Although some additional programming could be needed
  - **Tight integration of parallel libraries**
    - Supported through a SGE specific version of “rsh”, called “qrsh”
  - **Flexible Scheduling Polices**
  - Implements **Calendars**
    - Fluctuating Resources
  - **Intuitive Graphic Interface**
    - Used by users to manage jobs and by admins to configure and monitor their cluster
  - **Good Documentation**
  - Still Work in Progress
    - Observed flaws maybe addressed to dedicated teams and support is assureb by dedicated staff

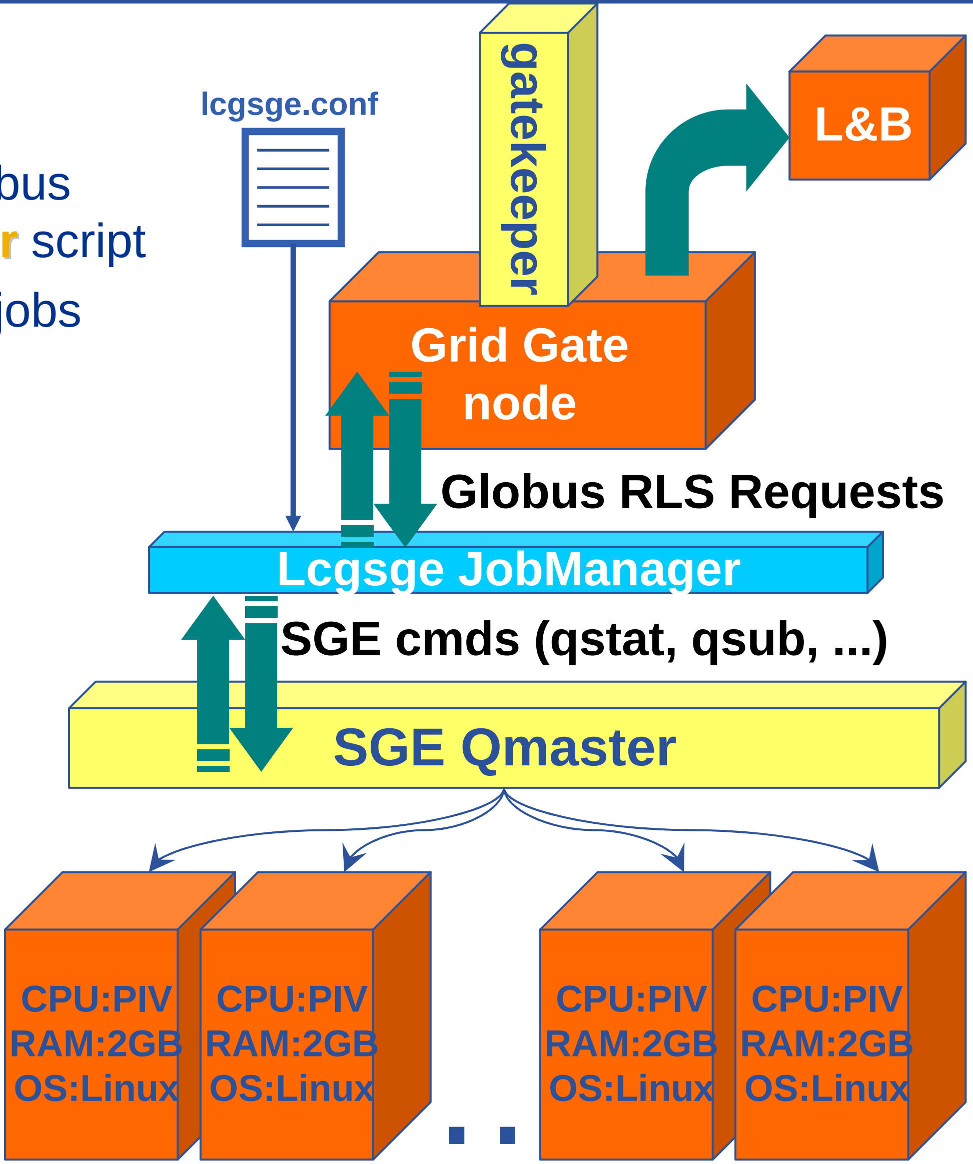
LCGSGE JobManager (1)

- **The JM is the core service of the Globus GRAM Service**
  - Submits jobs to SGE based on Globus requests and through a **jobwrapper** script
  - Intermediary to query the status of jobs and to cancel them

- **SGE command client tools (qstat, qsub, qdel) have to be available in the CE**
  - Even if the Qmaster machine is installed in another machine

- **Doesn’t require shared homes**
  - But home dirs must have the same path on the CE and WNs

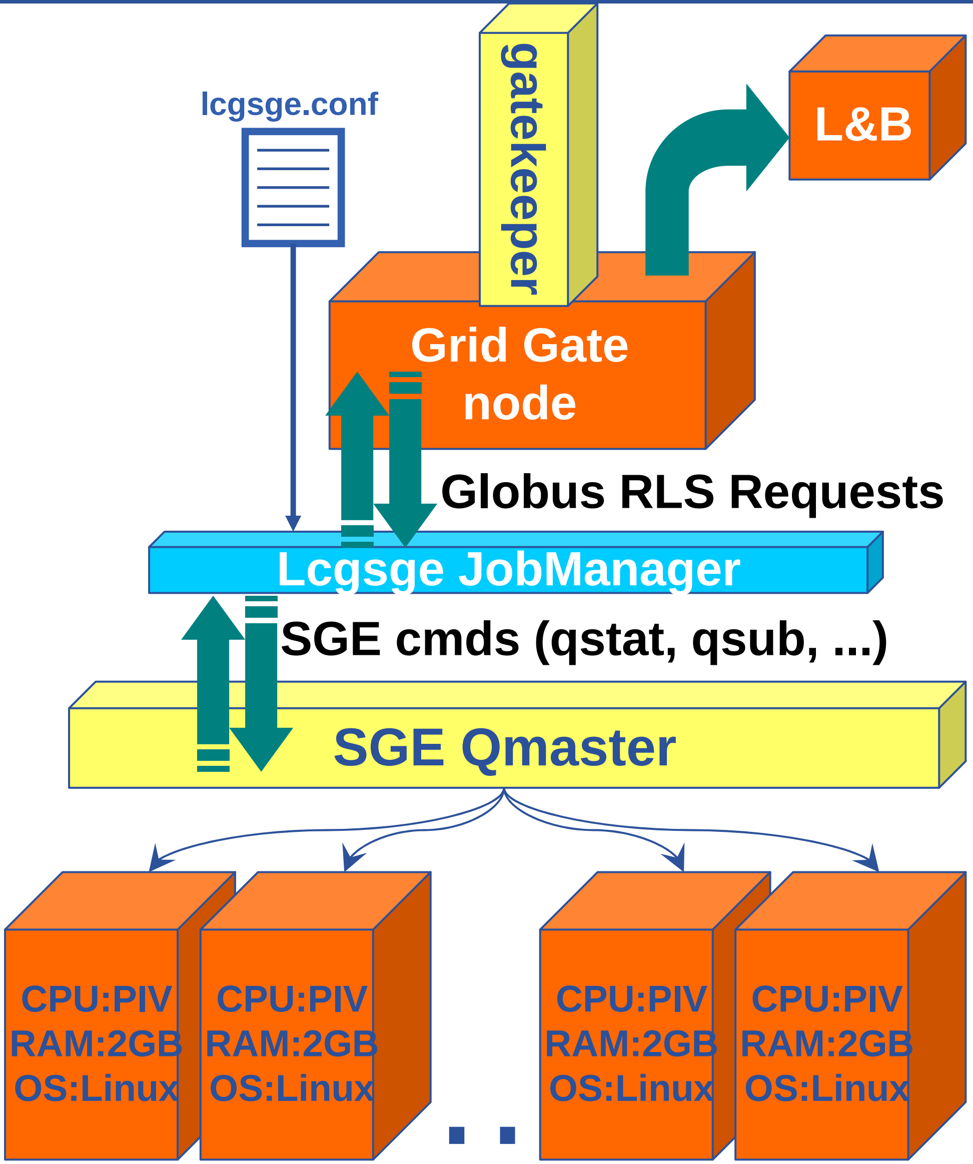
- **The SGE JM is based on the LCGPBS JM**
  - Requires XML::Simple.pm



LCGSGE JobManager (2)

SGE JM re-implements the following functions:

- **Submit**: Checks Globus RSL arguments returning a Globus error if the arguments are not valid or if there are no resources
- **Submit_to_batch_system**: Submits jobs to SGE, after building the **jobwrapper** script, by getting the necessary information from the RSL variables
- **Poll**: Links the present status of jobs running in SGE with the Globus appropriate message
- **Poll_batch_system**: Allows to know the status of running jobs parsing the **qstat** SGE output.
- **Cancel_in_batch_system**: Cancels jobs running in SGE using **qdel**

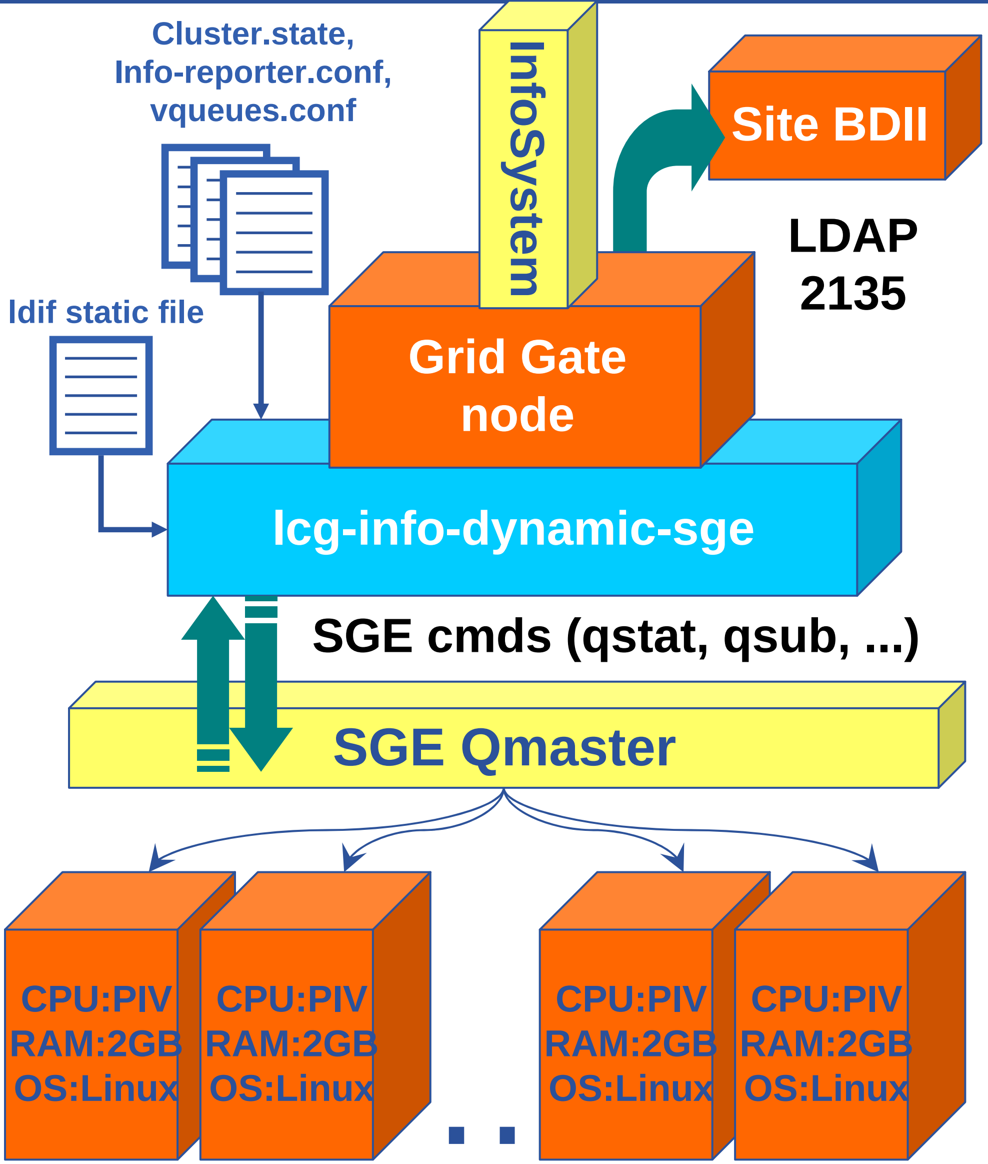


SGE Information Plugin (1)

- The solution implemented for SGE does not currently use the generic EGEE scripts
  - lcg-info-dynamic-sge”
    - A standalone Information plugin script that examines SGE queuing system state

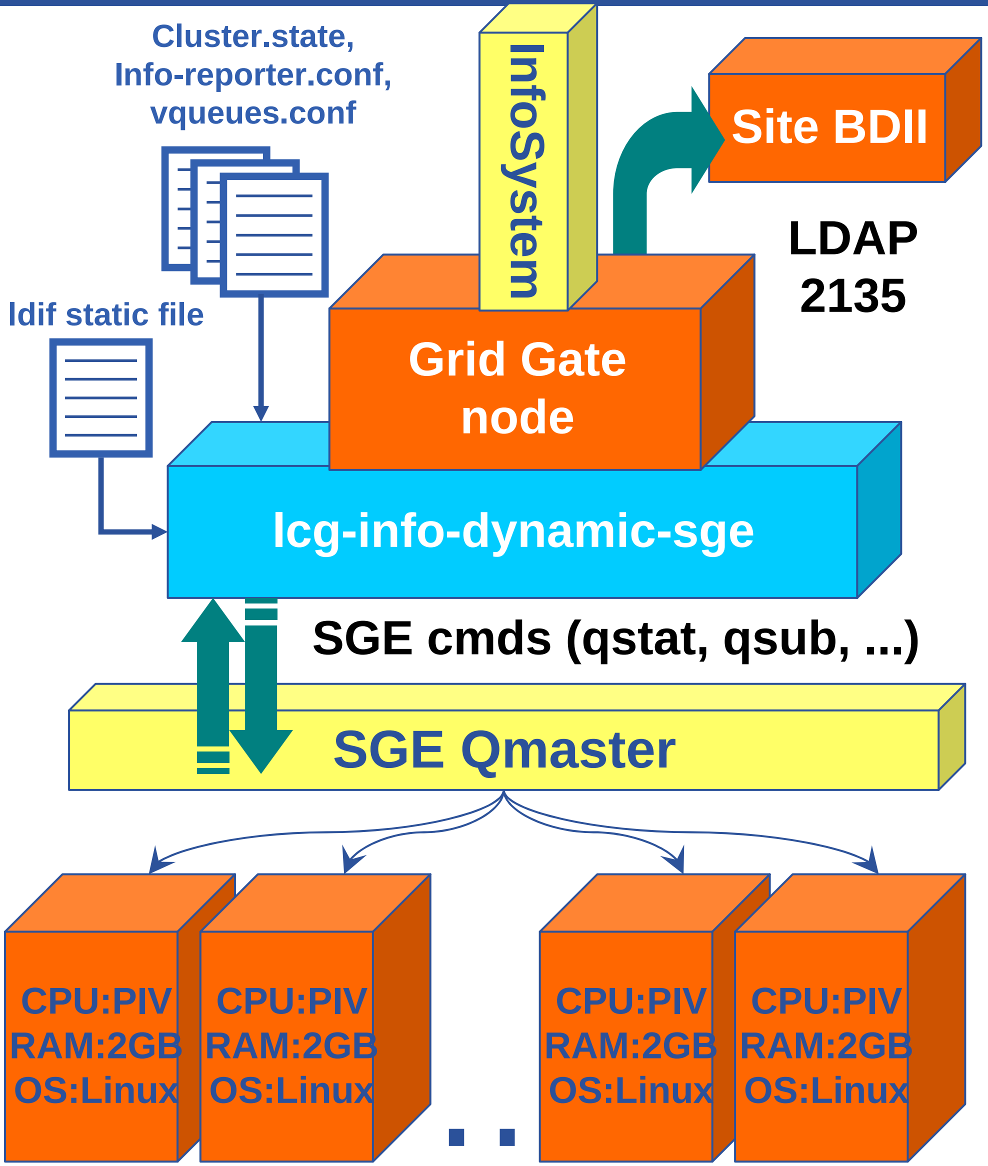
- Information expected to be reported is based on queues
  - SGE does not assign a job to a queue until execution time.
  - ``virtual queues" are used

- The info reporter reads…
  - A copy of a static ldif file with details of all ``virtual queues“
  - Config files specifying how virtual queues map into a list of resource requirements



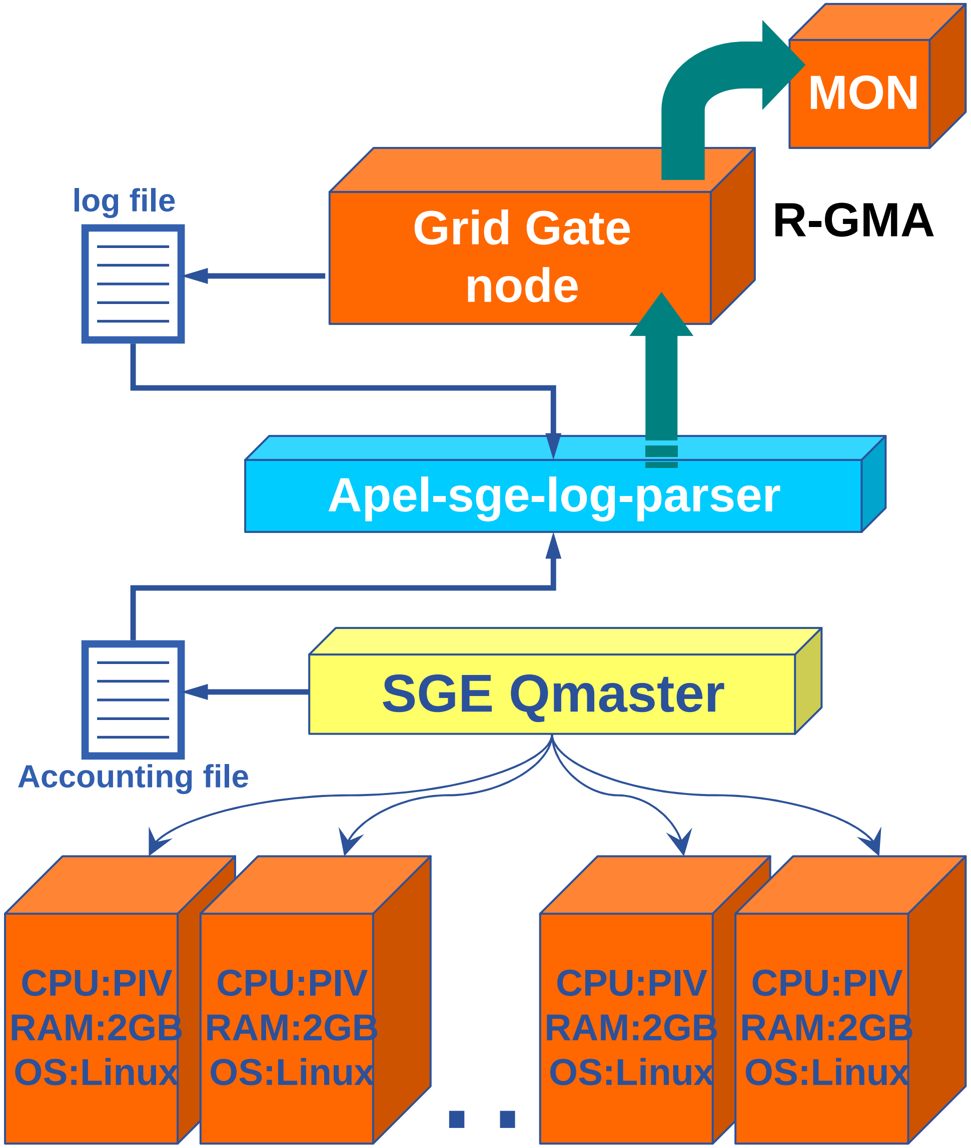
SGE Information Plugin (2)

- The dynamic information
  - single call to SGE's ``qstat"
- The system determines which virtual queues the job should be associated with
- Each virtual queue is considered to count up
  - Nb of job slots, Nb of pending/running jobs
  - Total amount of runtime left on all of the jobs assuming that they will run for their max duration
- The state of the batch queues can change quite fast …
  - Option to capture a copy of all information provider input data, which can be replayed to the information provider



SGE Accounting Plugin

- APEL SGE plug-in is a log processing application
  - Used to produce CPU job accounting records
  - Interprets gatekeeper & batch system logs
- Requires the JM to add ``gridinfo" records in the log file
  - Standard Globus JMs do not log them but LCG JMs do it
- apel-sge-log-parser parses the SGE accounting log file
  - This information, together with the gridinfo mappings from the JobManager are joined together to form accounting records
  - Published using R-GMA to an accounting database.



SGE YAIM Integration (1)

- **YAIM (Yet Another Installation Method)**
  - Separates the instalation process from the configuration one
  - Based on a library of bash functions called by a configuration script
    - Functions needed by each node are defined in node-info.def file
    - The grid site topology is totally encapsulated on the site-info.def file

- **Development of two integration rpms**
  - lcgCE-yaimtosge-0.0.0-2.i386.rpm
  - gliteWN-yaimtosge-0.0.0-2.i386.rpm
  - Requirements
    - SGE installed (we presently made SGE rpms to install it)
    - lcg-CE and glite-WN
    - glite-yaim (>=3.0.0-34), perl-XML-Simple (>= 2.14-2.2), openmotif (>=2.2.3-5) and xorg-x11-xauth (>= 6.8.2-1)

SGE YAIM Integration (2)

- **$SGE_ROOT software dir must be set to /usr/local/sge/pro**
  - May be changed by the site admin in a future release
- **The SGE Qmaster can only be installed in the CE**
  - May be installed in another machine in a future release
- **Three new variables must be set in the site-info.def**
  - **SGE_QMASTER, DEFAULT_DOMAIN, ADMIN_EMAIL**
- **The integration rpms do...**
  - Change the **node-info.def** file to include two new node types
    - CE_sge and WN_sge
    - Run the same functions as the CE and WN nodes, plus at the end
      - *Config_sge_server and Config_sge_client*

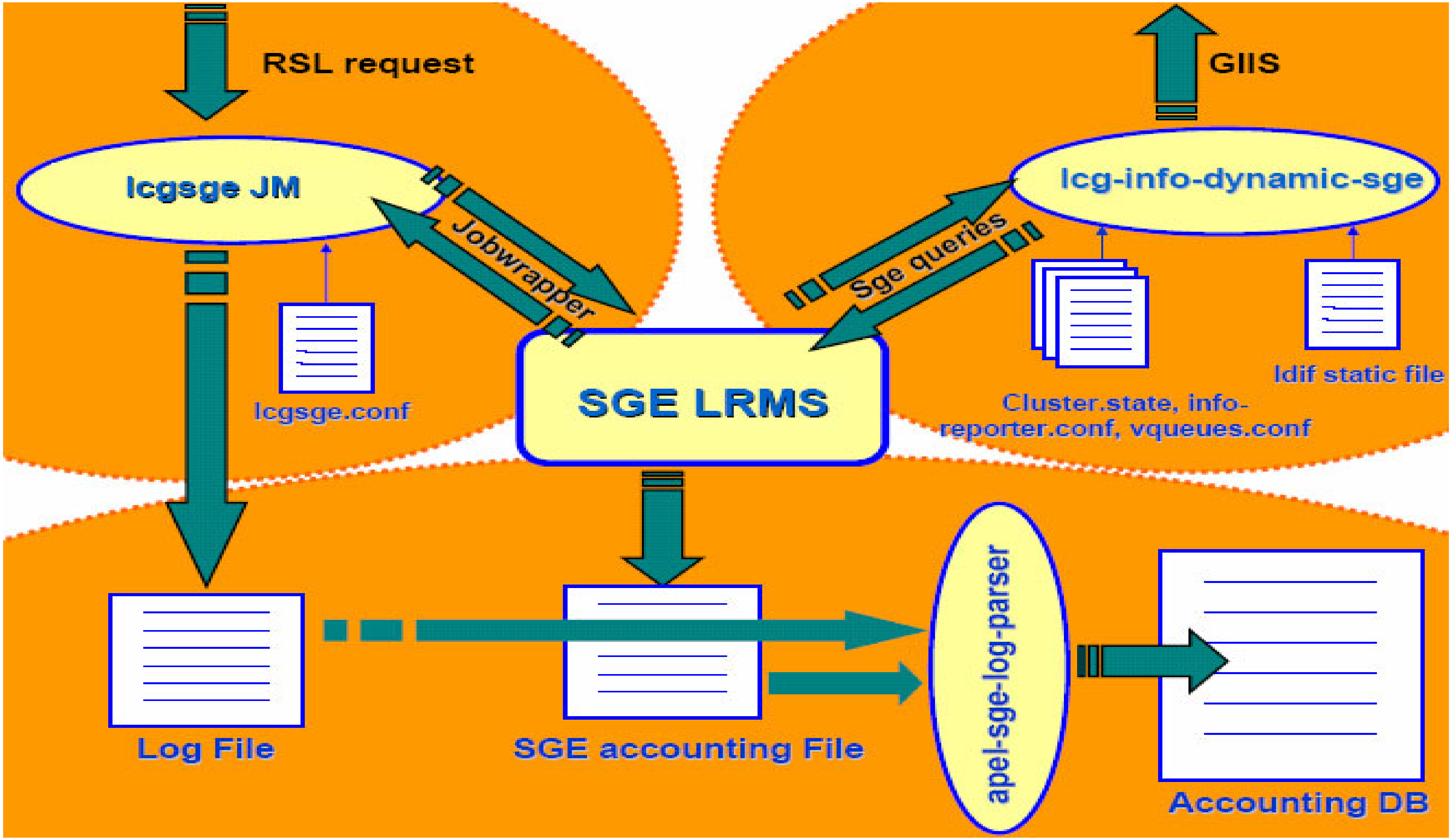
SGE YAIM Integration (3)

- **The Config_sge_server**
  - Uses an auxiliary perl script (**configure_sge_server.pm**)
    - Builds all the default SGE directory structure
    - Configures environment setting files, sets the global SGE configuration file, the SGE scheduler configuration file and SGE complex attributes
  - Defines one cluster queue for each VO
  - Deploys the **lcgsge JM** and builds its configuration files
  - Deploys **SGE Information plug-in** and builts its configuration files
  - Accounting is not properly integrated but will be soon...

- **The Config_sge_client**
  - Uses an auxiliary perl scrip (**configure_sge_client.pm**)
    - Builds all the default SGE directory structure in the client

SGE YAIM Integration (4)

- **/opt/glite/yaim/bin/yaim –c –s site-info.def –n CE_sge**



Future Work

- **SGE is working on a lcg-CE although additional work is required**
  - **YAIM SGE integration**
    - More flexible allowing site admins to dynamically set a broader range of options
    - Separate Qmaster from the CE
    - Fully integrate the SGE Accounting
  - **SGE Information Provider** needs to improve its flexibility and take into account overlapping cluster queues / virtual queues definitions

- **Started on integrating support for BLAHP, running on glite-CE**
  - Will be used within glite-CE and CREAM to interface with the LRMS
  - Expected to share the configuration files and concept of virtual queues with the information provider.
  - Other local middleware elements (GIIS, YAIM) basically remain unchanged for this glite-CE flavour.

- **Still missing**
  - GridICE sensors for SGE