Information, Operation and Monitoring in LCG

John Gordon
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Overview

• LCG Information System
• LCG Operations
  – operational monitoring
• A new monitoring framework for LCG
  – and other examples of monitoring
Acknowledgements

• Laurence Field
  – Deployment Team at CERN
• David Kant
  – LCG Grid Operations Centre
• Steve Fisher
  – Architect of R-GMA
LCG Information Service

- LCG started using MDS from Globus Toolkit
  - … but this did not stand up to the load of even the early stages of LCG
- The queries generated by the Resource Broker looking for information on all sites from top GIIS gave problems
  - serious users typically submit a lot of jobs at the same time
  - any site dropping out killed the whole tree
- Developments were started to improve reliability and robustness
• Berkeley Database Information Index
  – Because MDS is not production quality.
  – Standard openLDAP database.
  – Database populated by a Perl script.
  – RB queries BDII instead of GIIS
  – first developed by EU DataGrid
  – adopted and extended by LCG

• Recent improvements
  – Parallel population.
  – Improved configuration.
  – Automatic configuration update via web.
  – Can run information providers directly.
• Refresh script is run as cron job
• Refresh queries run on separate threads (thread=site??)
• Threads time-out if they fail to complete
• LDIF sources can be a script or an ldapsearch
Performance Tests

- Three different entry points tested
  - The top level, one stream.
  - The regional level, three streams.
  - The GIIS level, 25 streams.
  - All streams produced the same 1.8mb of data.
    - Equivalent to the data from 50 sites.
    - Tests re-tried with different query loads.

<table>
<thead>
<tr>
<th>Streams</th>
<th>No load, add</th>
<th>10 queries, add</th>
<th>No load, mod</th>
<th>10 queries, mod</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20s</td>
<td>24s</td>
<td>7s</td>
<td>16s</td>
</tr>
<tr>
<td>3</td>
<td>29s</td>
<td>50s</td>
<td>7s</td>
<td>39s</td>
</tr>
<tr>
<td>25</td>
<td>16s</td>
<td>24s</td>
<td>9s</td>
<td>17s</td>
</tr>
</tbody>
</table>

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Stress Test

• One Stream with a load of 10 queries
  – Simulated 50 sites with constant load.
  – Ran every 30s for 2 weeks.
  – Over 2 million queries.
  – No database corruption.
  – No re-starts required.

• Conclusions from the Test
  – Robust enough for production.
  – Use small data size and many streams.
    • BDII should go directly to site GIIS
A BDII view

- The lcg-bdii-update config file
  - Contains list of site GIISs.
  - Different BDIIIs could contain different lists of GIISs.
    - The list will give the BDII a “view” of the grid.
  - Name associated with LDIF URL.
    - “BDII LDIF Region”
    - Used for fault tolerance

- Automatic update
  - Config file automatically updated from a web page.
    - Can be centrally controlled (eg by operations centre).
    - BDIIIs using the same page will have the same view.
      - load balancing
Example Configuration

Date=02/03/04 19:00


#CERN, Geneva, Switzerland
CERN-LCG2 ldap://lxn1181.cern.ch:2135/mds-vo-name=cernlcg2/o=grid

#CNAF, Italy
CNAF-LCG2 ldap://wn-04-07-02-a.cr.cnaf.infn.it:2135/mds-vo-name=cnaflcg2/o=grid

#RAL, UK
RAL-LCG2 ldap://lcgce02.gridpp.rl.ac.uk:2135/mds-vo-name=rallcg2/o=grid

#NIKHEF, Netherlands
NIKHEF ldap://tbn18.nikhef.nl:2135/mds-vo-name=nikheflcgprod/o=grid

#FZK, Germany
FZK-LCG2 ldap://gridkap01.fzk.de:2135/mds-vo-name=fzk1cg2/o=grid

#Taiwan
Taiwan-LCG2 ldap://lcg00125.grid.sinica.edu.tw:2135/mds-vo-name=taipeilcg2/o=grid

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Virtual Partitioning

Will appear as a grid made of sites in set A

Web Server (or local file)
http://Set-of-sites-A

Web Server (or local file)
http://Set-of-sites-B

Web Server (or local file)
http://Set-of-sites-A&B

Only sites from B

All sites from A&B

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Topologies

Flat Topology
(scales up to at least 50 sites)

With regional fault tolerance
(increases scalability)

BDIIs can replace GIISs and GRISs
(no more dependency on globus MDS, but interoperates)
Generic Information provider

• A basic Information provider
  – Prints a static ldif file.
  – Glue Schema defines attributes.
  – Only need to create static ldif file.

• The problem is with dynamic information
  – Only a few attributes.
  – Use plug-in script to obtain the information.
  – Over-write the values when printing.

• Common components for all providers
  – Require a template file for each type.
    • Derived from the schema.
  – A plug-in script for each different system.
    • Eg. batch system, storage system
  – Uses same configuration framework for all.
Glue Schema

• Having a common schema is good
  – Glue Schema developed by EDG/DataTAG/Globus
  – for CE, SE, Networking
  – original Globus schema was only for single computers

• The current schema has many problems
  – Weakly defined.
  – Semantics not always clear
  – Affects interoperation between US & EU Grids (why? aren’t we using the same version?)

• “Misuse” of the schema
  – Use cases not defined

• Still need to solve this?
Information Summary

- LCG has replaced MDS by EDG BDII
  - and developed it further
- UK NGS has also adopted BDII
  - Grid3 has also replaced MDS by a different database solution
- This seems to have solved performance and reliability problems
  - but still leaves semantic problems with GLUE schema
Grid Operations

• Once middleware has been developed, tested and deployed, **grid operations** are the set of actions and procedures to keep a grid running for the users.
The Vision

• GOC Processes and Activities
  – Coordinating Grid Operations
  – Defining Service Level Parameters
  – Monitoring Service Performance Levels
  – First-Level Fault Analysis
  – Interacting with Local Support Groups
  – Coordinating Security Activities
  – Operations Development
Have we delivered?

• Coordinating Grid Operations
• Defining Service Level Parameters
• Monitoring Service Performance Levels
• First-Level Fault Analysis
• Interacting with Local Support Groups
• Coordinating Security Activities
• Operations Development

• Yes, RAL & Taipei
• No
• up or down
• Yes
• Yes
• Policies, not operation
• Monitoring and accounting
Monitoring the Grid is a Challenge!

The LHC Computing Grid, LCG, which was launched in September 2003 with 12 sites contributing, has been growing very rapidly. A snapshot of the 64 sites that were actively contributing to the LCG by mid-July is shown in the map above, which also provides a dynamic view of ongoing activity on the LCG. This map can be accessed at http://goc.grid-support.ac.uk/log2
Monitoring Services

- There are many frameworks which can be used to monitor distributed environments
  - MAPCENTRE http://mapcenter.in2p3.fr/
  - GPPMON http://goc.grid-support.ac.uk/
  - GRIDICE http://grid-ice.esc.rl.ac.uk
  - NAGIOS http://www.nagios.org/
  - MONALISA http://monalisa.cacr.caltech.edu/
  - GIIS Monitor http://goc.grid.sinica.edu.tw/gstat/
  - Ganglia

  - Example: Mapcentre 30 sites ~ 500 lines in config file (static version)
  - Example: Nagios 30 sites, 12 individual config files with dependencies

  - Developed Tools to Configure these services to make the job easier
    NAGIOS, MAPCENTER and GPPMON

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Secure Database Management via HTTPS / X.509
People, Contact Information, Resources
Scheduled Maintenance

GOC Configuration Database

Resource Centre
Resources & Site Information
EDG, LCG-1, LCG-2, …

https
MySQL

GOC GridSite

SERVER

Monitoring

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LCG2 Site Status: 21 July 2004 10.00am
Service Summary for Nodes:

Certificate Lifetime Check, GridFTP, GRAM Authentication

<table>
<thead>
<tr>
<th>HOST</th>
<th>PLUGIN</th>
<th>STATUS</th>
<th>Last Check</th>
<th>Duration</th>
<th>Attempt</th>
<th>Status Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>adc0015.cern.ch</td>
<td>Certificate Lifetime</td>
<td>OK</td>
<td>03-02-2004 13:27:59</td>
<td>7d 21h 49m 45s</td>
<td>1/3</td>
<td>Certificate expires: (36)wks,(0)days,(0)hrs,(21)min,(34)sec</td>
</tr>
<tr>
<td></td>
<td>GlueCEInfoHostName</td>
<td>OK</td>
<td>03-02-2004 12:41:39</td>
<td>7d 21h 11m 39s</td>
<td>1/3</td>
<td>GlueCEInfoHostName attribute is adc0015.cern.ch</td>
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<tr>
<td></td>
<td>siteName</td>
<td>OK</td>
<td>03-02-2004 12:54:40</td>
<td>7d 20h 58m 7s</td>
<td>1/3</td>
<td>siteName is CERN-LCG1 dataGridVersion is LCG1-1_1_3</td>
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<tr>
<td></td>
<td>GateKeeper Authentication Test</td>
<td>OK</td>
<td>03-02-2004 13:07:49</td>
<td>7d 21h 49m 29s</td>
<td>1/3</td>
<td>GRAM Authentication test successful</td>
</tr>
<tr>
<td>GridFTP Service</td>
<td></td>
<td>OK</td>
<td>03-02-2004 13:28:00</td>
<td>7d 21h 31m 7s</td>
<td>1/3</td>
<td>GRIDFTP Test Pass</td>
</tr>
<tr>
<td>atlasgrid01.usatlas.bnl.gov</td>
<td>Certificate Lifetime</td>
<td>OK</td>
<td>03-02-2004 13:26:00</td>
<td>7d 21h 30m 25s</td>
<td>1/3</td>
<td>Certificate expires: (46)wks,(0)days,(0)hrs,(42)min,(29)sec</td>
</tr>
<tr>
<td></td>
<td>GlueCEInfoHostName</td>
<td>CRITICAL</td>
<td>03-02-2004 12:43:00</td>
<td>7d 21h 48m 20s</td>
<td>1/3</td>
<td>IO::Socket::INET: connect: Connection refused</td>
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<tr>
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<td>03-02-2004 12:55:32</td>
<td>7d 20h 57m 13s</td>
<td>1/3</td>
<td>IO::Socket::INET: connect: Connection refused</td>
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<tr>
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<tr>
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</tbody>
</table>
## GridICE - 1

[http://grid-ice.esc.rl.ac.uk/gridice](http://grid-ice.esc.rl.ac.uk/gridice)

**GridICE**

[Logo Image]

**Site view**  |  **YO view**  |  **Geo view**  |  **Gri's view**  |  **Help**  |  **about**
---|---|---|---|---|---

### Computing Resources

<table>
<thead>
<tr>
<th>Site</th>
<th>Slot#</th>
<th>SlotFree</th>
<th>SlotLoad</th>
<th>RunJob</th>
<th>WaitJob</th>
<th>Power</th>
<th>CPU#</th>
<th>CPULoad</th>
<th>Available</th>
<th>Total</th>
<th>%</th>
</tr>
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<tr>
<td>cern.ch</td>
<td>408</td>
<td>180</td>
<td>60%</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>67.5 Gb</td>
<td>69.1 Gb</td>
<td>2%</td>
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<td>cnaf.infn.it</td>
<td></td>
<td></td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>cr.cnaf.infn.it</td>
<td>2154</td>
<td>1036</td>
<td>53%</td>
<td>253</td>
<td>0</td>
<td>762647</td>
<td>387</td>
<td>5%</td>
<td>868.0 Gb</td>
<td>999.7 Gb</td>
<td>1%</td>
</tr>
<tr>
<td>fnal.gov</td>
<td>12</td>
<td>12</td>
<td>100%</td>
<td>0</td>
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<td>-</td>
<td>-</td>
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<td>fzk.de</td>
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<td></td>
<td></td>
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<tr>
<td>gridka.de</td>
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<td></td>
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<tr>
<td>gridpp.rl.ac.uk</td>
<td>458</td>
<td>273</td>
<td>57%</td>
<td>55</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>59.8 Gb</td>
<td>69.0 Gb</td>
<td>1%</td>
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<tr>
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<td>294</td>
<td>294</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>126</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.2 Gb</td>
<td>16.8 Gb</td>
<td>5%</td>
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<tr>
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<td>460</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>433979</td>
<td>160</td>
<td>0%</td>
<td>5.6 Tb</td>
<td>22.4 Tb</td>
<td>25%</td>
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<tr>
<td>nikhef.nl</td>
<td>500</td>
<td>230</td>
<td>56%</td>
<td>137</td>
<td>13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.4 Tb</td>
<td>1.7 Tb</td>
<td>24%</td>
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<tr>
<td>triumf.ca</td>
<td>4490</td>
<td>30</td>
<td>55%</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>729.1 Tb</td>
<td>731.1 Gb</td>
<td>6%</td>
</tr>
</tbody>
</table>

**TOTAL** | **8902** | **2711** | **445** | **13** | **1196525** | **547** | **20%** | **8.6 Tb** | **25.9 Tb** | **17%** |

**Generated:** Mon, 22 Mar 2004 15:50:30 +0000

[GridICE Homepage]
<table>
<thead>
<tr>
<th>Process Name</th>
<th>Status</th>
<th>Inst#</th>
<th>Instances</th>
<th>CPU</th>
<th>Memory</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>condor-scheduler</td>
<td>S</td>
<td>1</td>
<td>1-3:15</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>condor-master</td>
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<td>1</td>
<td>1-3:15</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>fmon-agent</td>
<td>S</td>
<td>1</td>
<td>1-3:16</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ftp-server</td>
<td>S</td>
<td>1</td>
<td>1-2:16</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>job-controller</td>
<td>S</td>
<td>1</td>
<td>1-3:15</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>local-logger</td>
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<td>1</td>
<td>1-2:1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>local-logger-interlog</td>
<td>S</td>
<td>1</td>
<td>1-4:1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>logging-and-bookkeeping</td>
<td>S</td>
<td>1</td>
<td>1-2:55</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>log-monitor</td>
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<td>1-3:11</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>network-server</td>
<td>S</td>
<td>1</td>
<td>1-3:13</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>proxy-renewal</td>
<td>S</td>
<td>4</td>
<td>1-3:16</td>
<td>0</td>
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<td>0</td>
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<td>workload-manager</td>
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<td>4</td>
<td>1-3:16</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Generated: Tue, 23 Mar 2004 15:12:58 +0000
Ganglia Monitoring - 1

- [http://gridpp.ac.uk/ganglia](http://gridpp.ac.uk/ganglia)
- Can use Ganglia to monitor a cluster

![Ganglia Monitoring Graph]

RAL Tier-1 Centre
LCG PBS Server displays Job status for each VO

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Ganglia Monitoring - 2

GridPP Grid (2 sources) (tree view)
- CPUs Total: 1036
- Hosts up: 437
- Hosts down: 9
- Avg Load (15, 5, 1m): 20%, 24%, 24%
- Localtime: 2004-07-22 18:26

DZeroFarm ManHEP (physical view)
- CPUs Total: 47
- Hosts up: 24
- Hosts down: 2
- Avg Load (15, 5, 1m): 44%, 45%, 44%
- Localtime: 2004-07-22 18:26

- Can also use Ganglia to monitor clusters of clusters

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LCG2 Site Status: 21 July 2004 10.00am

Status for Resource Broker CERN_lxn1188: Wed Jul 21 09:45:12 BST 2004
Regional Monitoring - 2

- http://goc.grid-support.ac.uk/roc_map/map.php
- Active map to select individual regions
Regional Monitoring - 3

UK/I Monitoring displays GRIDPP and NGS resources.
Replica Manager Tests - 2

http://goc.grid-support.ac.uk/gridsite/status/rmtest.php?action=table

Results of each test are shown as a coloured index on the map.

Distinguish between jobs that have completed, or have failed or still running.
### GIIS Monitor Information

<table>
<thead>
<tr>
<th>Site CE</th>
<th>GIIS Monitor</th>
<th>PrintInfo</th>
<th>CopyAndReg. WN -&gt; defaultSE</th>
<th>Copy defaultSE -&gt; WN</th>
<th>Replicate defaultSE to castorgrid</th>
<th>3rd Party Rep. castorgrid to defaultSE</th>
<th>Copy replica to WN</th>
<th>Delete Replica from defaultSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>atlasse.inf.infn.it</td>
<td>ldap://ibm140.cnaf.infn.it:2170</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>atlasse.int.infn.it</td>
<td>ldap://ibm140.cnaf.infn.it:2170</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>biogmc-lpc-clc.physics.utoronto.ca</td>
<td>ldap://lbn1189.cern.ch:2170</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
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<td>ldap://lbn1189.cern.ch:2170</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>cldapref1.in2p3.fr</td>
<td>ldap://lbn1189.cern.ch:2170</td>
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<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
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<td>FAILED</td>
<td>FAILED</td>
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<td>OK</td>
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<td>OK</td>
</tr>
<tr>
<td>ce1.co.rhu.ac.uk</td>
<td>ldap://lbn1189.cern.ch:2170</td>
<td>OK</td>
<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
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<tr>
<td>ce.qrdpp.shef.ac.uk</td>
<td>ldap://lbn1189.cern.ch:2170</td>
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<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
<td>OK</td>
</tr>
<tr>
<td>czech.rep.cz</td>
<td>ldap://lza15.sipn.msu.ru:2170</td>
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<tr>
<td>ce.prd.hp.com</td>
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<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
<td>FAILED</td>
</tr>
</tbody>
</table>

### Description of the tests

- **CopyAndReg. WN -> defaultSE**
- **Copy defaultSE -> WN**
- **Replicate defaultSE to castorgrid**
- **3rd Party Rep. castorgrid to defaultSE**
- **Copy replica to WN**
- **Delete Replica from defaultSE**

---

**Job Outputs**

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GIIS Monitor

- Developed by MinTsai (GOC Taipei)
- Tool to display and check information published by the site GIIS
Operational Monitoring

- Lots of tools
- Integrated with central configuration database
- Combining tools for more diagnosis
- Next step to implement as web services

- Only covers remote monitoring of services and sites
- What do we do about more fine-grained monitoring?
R-GMA

- A relational implementation of GMA (from GGF)
  - Powerful data model and query language
    - All data modelled as tables
    - SQL can express complex queries in one expression
- Creates impression that you have one RDBMS per VO
R-GMA

Producer API
SQL “CREATE TABLE”
SQL “INSERT”
TableName
Value 1 | Value 2

Producer Servlet
TableName
Value 1 | Value 2

Schema
TableName | Column

Registry
TableName | URL | Predicate

Consumer API
SQL “SELECT”
TableName
Value 1 | Value 2

Consumer Servlet
TableName
Value 1 | Value 2

Insert
Execute or stream
Store location
Store table description
Lookup location

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An example R-GMA system

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R-GMA examples

- BOSS
  - CMS job monitoring
- EDG Network Monitoring
- LCG Accounting
- R-GMA part of LCG 2.1.1
Results: job time statistic

Dataset bt03_ttb_tTH analysed with executable ttHWmu

- **Total execution time** ~ 28 minutes
- **ORCA execution time** ~ 25 minutes

- **Job waiting time before starting** ~ 120 s
- **Time for staging input and output files** ~ 170 s

Overhead of GRID + waiting time in queue
EDG-network monitoring

### Network Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>CH CERN</th>
<th>FR IN2P3-LYON</th>
<th>IT CNAF</th>
<th>NL NIKHEF</th>
<th>UK RAL-GRIDPP</th>
<th>Sum</th>
<th>Avg</th>
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</thead>
<tbody>
<tr>
<td>TCP Throughput</td>
<td>79.94</td>
<td>63.06</td>
<td>73.91</td>
<td>75.76</td>
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<td>ICMP RTT</td>
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<td>63.34</td>
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<td>46.42</td>
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<td>63.25</td>
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<tr>
<td>UDP Throughput</td>
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<td>63.34</td>
<td>73.34</td>
<td>72.38</td>
<td>46.42</td>
<td>253</td>
<td>63.25</td>
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<tr>
<td>One Way IPDV</td>
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<td>83.69</td>
<td>63.69</td>
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<td>75.48</td>
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<tr>
<td>NL NIKHEF</td>
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<td>69.75</td>
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<td>NL SARH</td>
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<td>74.77</td>
<td>67.71</td>
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<td>76.28</td>
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<tr>
<td>UK RAL-GRIDPP</td>
<td>23.38</td>
<td>67.74</td>
<td>84.38</td>
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<tr>
<td>UK UCL</td>
<td>23.38</td>
<td>67.74</td>
<td>84.38</td>
<td>91.16</td>
<td>84.38</td>
<td>287.7</td>
<td>71.92</td>
</tr>
<tr>
<td>Avg</td>
<td>66.46</td>
<td>69.63</td>
<td>74.65</td>
<td>78.17</td>
<td>68.1</td>
<td>71.35</td>
<td></td>
</tr>
</tbody>
</table>

### GridFTP Traffic

- GridFTP Performances
- GridFTP vs TCP
- TCP vs RTT

### Advanced

- Grid Elements mappings
- Last values raw
- Last values matrices
- Monitoring matrices

### Network Metrics Matrices

- Raw data (graph+text)
- Traffic matrices per node
- Total Traffic Graph

### Dates
- Last 30 days

### Start and End
- 2003/09/09 00:07:16 GMT

### Function
- Average
- Matrix

Table: NetworkTCPThroughput
Field: value
Unit: Mbit/s
Job Accounting - 2

- Offline testing of program using data from the CORE sites completed.
- Development of an accounting portal underway to provide accounting **on-demand** for each site, and aggregated for each EGEE region.
- Challenge! Deal with large database 1 ROW per LCGPBS Job per Site!
- [http://goc-dev.esc.rl.ac.uk/jpg/goc_demo.php](http://goc-dev.esc.rl.ac.uk/jpg/goc_demo.php)
- [http://goc-dev.esc.rl.ac.uk/jpg/goc_demo3.php](http://goc-dev.esc.rl.ac.uk/jpg/goc_demo3.php)

**BaseCpuSeconds**

![BaseCpuSeconds Graph](chart.png)
Summary

• LCG has replaced Globus information service components
  – configuration allows definition of virtual grids
• Operational Monitoring combines a wide range of existing tools
  – and is integrating them
• R-GMA provides