Grid Interoperation with ARC Middleware for CMS Experiment

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On behalf of CMS Offline and Computing
Outline

- CMS experiment
- NorduGrid/ARC middleware
- CMS computing in Finland
- Grid interoperation
- CMS transfers and data management
- CMS data analysis
- CMS production
Proton-proton collisions will start at the LHC in 2009. Experiments like Compact Muon Solenoid (CMS) will produce Petabytes of data per year.

CMS data is managed and analysed using three different grid middleware infrastructures: gLite, OSG and NorduGrid/ARC.

Main computing tools used by CMS experiment include e.g. PhEDEx (data transfers), ProdAgent (MC production, central processing) and CRAB (data analysis).
Advanced Resource Connector (ARC) developed and maintained by NorduGrid collaboration

Used in production environment since 2002. Many other projects use ARC including the Nordic Data Grid Facility (NDGF), the distributed Tier-1 in the Nordic countries

ARC is designed to be scalable, non-intrusive and portable.

<table>
<thead>
<tr>
<th></th>
<th>gLite</th>
<th>ARC</th>
</tr>
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<tbody>
<tr>
<td>Job submission</td>
<td>GRAM</td>
<td>gridftp</td>
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<tr>
<td>Job description</td>
<td>JDL</td>
<td>xRSL</td>
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<tr>
<td>Brokering</td>
<td>WMS</td>
<td>client</td>
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<tr>
<td>Schema</td>
<td>GLUE</td>
<td>ARC</td>
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<tr>
<td>Storage interface</td>
<td>SRM</td>
<td>SRM</td>
</tr>
<tr>
<td>Security</td>
<td>GSI</td>
<td>GSI</td>
</tr>
</tbody>
</table>
CMS Computing In Finland, Why ARC?

- Finnish grid infrastructure (e.g. M-grid) already based on ARC. Future projects likely to follow same model.
- ARC is stable and portable. 64-bit systems used since 2005 on M-grid.
- Our experience: ARC system installation and maintenance is relatively easy. With ARC can easily share non-dedicated resources with other sciences.
- Nordic DataGrid Facility (NDGF), the distributed Nordic Tier-1 center for ALICE and ATLAS uses ARC. NDGF provides support and services.

Finnish ARC Computing Elements:

<table>
<thead>
<tr>
<th>Finland</th>
<th>Akaatti (M-grid)</th>
<th>208</th>
<th>6+116</th>
</tr>
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<tbody>
<tr>
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<td>Ametisti (M-grid)</td>
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<td>12+106</td>
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<tr>
<td></td>
<td>Jaspis (M-grid, HIP)</td>
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<tr>
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<td>Kinini (CSC)</td>
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<tr>
<td></td>
<td>Kvartsi (M-grid)</td>
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<tr>
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<td>Liuske (CSC test)</td>
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<tr>
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<tr>
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<td>Sepeli</td>
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<tr>
<td></td>
<td>Spektrolitli (M-grid)</td>
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</tr>
<tr>
<td></td>
<td>Topaasi (M-grid)</td>
<td>82</td>
<td>6+88</td>
</tr>
</tbody>
</table>
Using Multiple Grids

- Interoperability: ability to exchange information and use resources
- Interoperation: actual use of interoperable systems

Different models for interoperation:
- More than one grid middleware installed at one site
- Building gateways between grids
- Common standards and interfaces (long term goal)
- User driven approach: build plugins for each grid
• ARC client tools (or gLite, dCache clients) can be used for GSI, security, data management.
• CMS data transfers with Physics Experiment Data Export (PhEDEx).
• Data storage using e.g. dCache, standard SRM interface.
• Other services like Frontier work without problems.
• CMS Remote Analysis Builder (CRAB) is used to build and submit CMS grid analysis jobs
• CRAB is middleware independent and supports different grids (gLite, OSG) with plugins.
• CRAB plugins for ARC are under development, job submission already works.
• Currently CRAB (user and JobRobot) jobs can be submitted to ARC resources using gateway based grid interoperation
WMS gateway for CMS data analysis on ARC

- Information system: dedicated NDGF-BDII translates information retrieved from ARC sites
- Grid job handling:
  - gLite jobs submitted with glite-wms-job-submit
  - Condor-G component in gLite-WMS can also submit jobs to ARC resources using GridFTP protocol
- gLite Runtime Environment (RTE) required on ARC CE
- Currently a dedicated ARC-WMS at CERN: can be used by setting wms_service and CE_white_list in CRAB configuration file (crab.cfg)
- WMS patches for ARC submission are in certification process and will be included in gLite distribution
- More than 99% of test CRAB jobs successful with this scheme. Can be used with arbitrary jobs with no job changes.
CMS Monte Carlo production workflows are distributed to multiple ProdAgents that have CPU and storage at their disposal (Tier-1 or Tier-2 site).

ProdAgent has a system of plugins to enable it to use different middlewares and batch queue systems (e.g. gLite, Condor and OSG).

A set of ProdAgent plugins (1600 lines of python) for ARC has been developed:

- ARCCreator: generates job scripts
- ARCMonitor: releases jobs from internal queue when free resources are available
- ARCSSubmitter: submits jobs
- ARCTracker: tracks job status, and fetches jobs when done
- ARCKiller: kills jobs

These plugins are used by the central CMS production team to produce official datasets (e.g. /H200_ZZ_2lqq/Summer08 IDEAL_V9_v1/GEN-SIM-RECO) in the Finnish Tier-2 resource.
ARC in CMS production

ProdAgent software

Prod requests

Send work, report progress

ProdAgent

ProdAgent

ProdAgent

gLite Condor-G glideinWMS ARC

gLite Condor-G glideinWMS ARC

gLite Condor-G glideinWMS ARC

Grid jobs

gLite CE

OSG CE

ARC CE
Summary

- Grid interoperation improving and standards are getting closer. Implementing large scale interoperation with current systems is still time consuming.
- General application independent interoperation between gLite and ARC possible using gateway approach (modified WMS). Currently used for CRAB jobs.
- Special ARC plugins for ProdAgent developed and used in CMS MC production.
- Main software components of CMS experiment (production, analysis) work with ARC middleware. Work still continues.