An Objective Comparison Test of Workload Management Systems

by

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Available WMSes

- **General purpose**
  - Condor-G
  - ReSS
  - gLite WMS
  - glideinWMS

- **Experiment/group specific**
  - Panda
  - CRONUS
  - ALIEN
  - DIRAC
  - GlideCAF
  - etc.
Tested WMSes

- General purpose
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  - ReSS
  - gLite WMS
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- Experiment/group specific
  - Panda
  - CRONUS
  - ALIEN

Testing response to job submissions
Condor-G

• Part of the Condor distribution
  – Although only loosely coupled with the rest of the Condor system

• Supports multiple submission portals
  – Pre-WS and WS Globus
  – Nordugrid
  – unicore, pbs and lsf

• Most other WMSes use it as the underlying submission mechanism to the Grid
Condor-G

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Condor-G submission speed

- At least up to 20k jobs seems to be linear
  - Approx 250 submissions per minute
Condor-G startup speed

• Not so linear
  − Linear with up to 7k jobs in the queue
  − Choked with 20k in the queue

All further tests done with at most 7k jobs in the queue

condor_gridmanager was using 100% of the CPU
Condor-G startup speed

- Startup speed a load tradeoff
  - With
    \[ \text{GRIDMANAGER\_MAX\_JOBMANAGERS\_PER\_RESOURCE} = 100 \]
    \~60 jobs per minute
  - With default
    \[ \text{GRIDMANAGER\_MAX\_JOBMANAGERS\_PER\_RESOURCE} = 10 \]
    \~30 jobs per minute
Condor-G removal speed

- Sometimes one does need to delete a large number of jobs
- Similar results as startup, but higher price diff
  - Again ~60 with $\text{GRIDMANAGER\_MAX\_JOBMANAGERS\_PER\_RESOURCE} = 100$
  - And ~30 with default $\text{GRIDMANAGER\_MAX\_JOBMANAGERS\_PER\_RESOURCE} = 10$

![Jobs for the last hour](chart1)

![Jobs for the last hour](chart2)

![Load/Processes](chart3)

![Load/Processes](chart4)
Condor-G and job length

• Given enough jobmanagers, Condor-G can saturate a big site
  – With 100 jobmanagers, 5k available slots and a job mix of 10min, 50min and 2h jobs, the limiting factor was the CE batch system

Condor-G running

CE status
Condor-G reliability

- Submitting to dedicated, well behaved site
  - No problems encountered if less than 7k jobs in queue
  - Given enough jobmanagers, both short and long jobs ran successfully

Mix of 10min, 50min and 2h jobs

Mix of 2h, 12h and 18h jobs
Condor-G reliability

- But misconfigured sites can destroy most of your jobs

- Condor-G also does not handle well CE crashes
  - Jobs may stay in the queue forever

This same site worked perfectly just the day before!
ReSS

- OSG **Resource Selection System** is a matchmaking system for Condor-G
  - Uses information gathered from via CEMon from Grid sites to make decisions
- The submission is still via the local Condor-G queue
  - ReSS choses the site to which to submit
  - Local Condor-G then handles the submission process
ReSS benchmarks

- Essentially the same as plain Condor-G
- Tested with 4x10k queued

2k slots on Grid site  
default Condor-G parameters
gLite WMS

• A portal solution
  – Users submit to the WMS and the WMS takes care of the submission
  – A dedicated client used for interaction

• Proprietary resource selection service inside
  – Uses BDII to gather information about the Grid sites

• Uses Condor-G internally for job submission
gLite WMS submission speed

• Way too slow
  – Only about 5 submission per minute

Even using advance delegation

Did not test anything else in single submission mode
gLite WMS collection mode

• In collection mode, the submission is very fast
  – ~1000 jobs submitted per minute
  – Collection made of 5k jobs submitted in 5 mins, a 20k collection took 23 mins

• Frequent temporary overloads
  – Only 7 out of 8 consecutive 5k submissions succeeded
    • Last one complained the WMS was overloaded (load>10)
  – Only 1 out of 8 parallel 5k submissions succeeded
    • The one that succeeded took 28mins
    • The others claimed the WMS was overloaded (load>10)
  – Going slowly, able to submit 4x20k collections
gLite WMS collection mode

• Getting the status of the job
  – A 5k collection takes 40s to query
  – A 20k collection takes approx. 3mins
    • Single job in collection takes a few seconds, on average
    • However, had to retry in several occasions (timeouted)
  – Provided you know the job identification string
    • Could not find an easy way to obtain list of own jobs

• Removing a collection is reasonably fast
  – The 20k collection removal command returned in 30s
    • But don't know how long it took for the internal WMS cleanup
  – With 7x5k in queue, a single 5k removal took ~1min
gLite WMS startup speed

- Have only results from Jan'07
- Tested 4x4k
  - Would not scale past that
- Using 2 sites, started max 20 jobs per min
gLite WMS reliability

- Internally uses Condor-G, so most problems the same
  - But it does retry a job several times if first submission fails
- Still several jobs failed in our tests
glideinWMS

• Condor glidein based WMS
  – Based on the pilot, or just-in-time philosophy
• User jobs are not directly submitted to the Grid
  – Instead, a Condor daemon (glidein) is submitted to the Grid using Condor-G
  – After the glidein registers back to the WMS, a user job with the highest priority is sent to that resource
• User jobs are usually vanilla Condor jobs
  – Although standard and MPI jobs are possible, too
glideinWMS submission speed\(^{(1)}\)

- Faster than Condor-G
  - Managed 400 submissions per minute

![Graph showing submission speed over time with a peak of 20k submissions in 50 minutes.](image)
glideinWMS submission speed

- Scales almost linearly with the number of submit schedds
glideinWMS startup speed (1)

- Initially same as Condor-G
  - ~30 jobs per minute
  - Limited by the rate of glidein submission
glideinWMS startup speed

- Once the glideins have started, startup rates much higher
  - ~200 jobs per minute
glideinWMS removal speed

- `condor_rm` returns within the second, even if removing 20k jobs at once
- Used slots are released at ~120 jobs per minute

- glideins die after 20 minutes if no new jobs

![Diagram showing glideinWMS removal speed](image)
glideinWMS reliability\(^{(1)}\)

- User jobs almost never fail
  - Problematic Grid sites/nodes kill glideins not user job
glideinWMS reliability

- If glidein dies after job started, Condor will restart the user job in another glidein
  - Just wasted CPU (Checkpointing can eliminate it)
GCB scalability

- Single GCB/schedd pair have limited scalability
  - Stable only to ~600 running jobs
  - Even if GCB configured to support 3k+ glideins (i.e. 100x200 connections)

Must install many to scale
Condor memory usage

- Condor uses ~1.3Mb of memory per running job for the condor_shadows

Must install high amount of memory or use several submit nodes
glideinWMS daemons load

- VO frontend uses up to a full CPU and up to 1GB of memory
- Glidein factory uses ~1/5 of a CPU and 20M of memory per served Grid site
  - Most load coming from monitoring
  - May need to deploy several if you want to serve all the Grid sites
WMS comparison

- The amount of service offered varies
  - Condor-G and ReSS provide just basic Grid submission and job retrial
  - gLite WMS is a black box, portal solution
    - Centralized optimizations
  - glideinWMS is a pilot based WMS
    - just-in-time scheduling
    - node validation and environment preparation
    - active job management
WMS comparison

• Approach to resource selection varies:
  – Condor-G relies on the user to select a site
  – ReSS relies on CEMon information from the sites
  – gLite WMS relies on BDII information from the sites
  – glideinWMS schedules user jobs only after the glideins start
    • To submit the glideins the WMS admin can use any of the above for configuration purposes
### WMS comparison

- Different amount of investment is needed for each of them:

<table>
<thead>
<tr>
<th>WMS</th>
<th>Client</th>
<th>Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condor-G</td>
<td>Light daemon</td>
<td>None</td>
</tr>
<tr>
<td>ReSS</td>
<td>Light daemon</td>
<td>Light daemon</td>
</tr>
<tr>
<td>gLite WMS</td>
<td>None</td>
<td>2 high end nodes (SL3 only)</td>
</tr>
<tr>
<td>glideinWMS</td>
<td>Heavyweight daemon</td>
<td>Several daemon nodes</td>
</tr>
</tbody>
</table>
WMS comparison

• They have different scalability limits
  – Condor-G scales well, providing you install multiple schedds
  – ReSS seems to have similar scalability potential as Condor-G
  – gLite WMS unusable in single job submission mode
    • Users must group jobs in collections
    • Seems to scale, but experienced temporary overloads
  – glideinWMS seems to scale well, but you need to dedicate a lot of hardware to it
Conclusions

• I hope this overview was useful
• As you can see, each system has its own strengths and weaknesses
• Your needs may vary, so will not give any recommendations