Operating the Worldwide LHC Computing Grid: current and future challenges

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on behalf of the WLCG Operations, Coordination and Commissioning Team

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• Introduction
• Review of the WLCG operations
• The WLCG operations coordination working group
• The task forces
• Future challenges
The Worldwide LHC Computing Grid supports the distributed computing for the LHC experiments

- Established in 2001, stable operations in 2010
- Jointly operated with EGI, OSG and NorduGrid

| Tier  | CPU (HS06) | Disk (PB) | Tape (PB) |
|-------|------------|-----------|-----------|
| 1 Tier-0 | 360,000 | 29,000 | 71,000 |
| 12 Tier-1 | 680,000 | 75,000 | 110,000 |
| 143 Tier-2 | 990,000 | 89,000 | |
| Total | 2,030,000 | 193,000 | 181,000 |
Data distribution and processing

• Older model:
  – Tier-0 focuses on first pass reconstruction and long term archival
  – Tier-1 on reprocessing and archival
  – Tier-2 on simulation and analysis

• But rapidly evolving towards a full mesh model with little distinction between Tier-N roles
  – Mostly about hosting central services, tape systems and data custodiality

C. Grandi et al, CMS Computing Model Evolution, CHEP2013
WLCG operations

• Evolved from a decade long experience in prototypes, service and data challenges
  – Result of the effort of many individuals
  – Use also procedures and tools provided by the federated Grid projects in addition to its own
    • GGUS, GOCDB, OIM, EGI portals, etc.
  – Initial focus on delivering a stable service rather than sustainability
  – Very successful but at the expense of a high manpower cost
• In 2011 WLCG decided that it was the right time for an internal review
  – The Technical Evolution Groups
  – Not just for operations
• Main challenges were (still are)
  – Operate the system with less effort
  – Evolve towards new distributed computing models
TEG operations review

• From October 2011 to April 2012 all aspects of WLCG operations were examined to describe the state of the art\(^{(1)}\) and identify issues
  – Monitoring and site quality metrics
  – Operational procedures and support tools
  – Management of application software
  – Middleware validation and deployment

• The activity resulted in a series of recommendations, to be followed up by a new, dedicated coordination body

(1) Girone M and Templon J 2012 Final report of the operations & tools technical evolution group (TEG) https://espace.cern.ch/WLCG-document-repository/
• WLCG operations reasonably smooth

Findings…

• The TEG highlighted some issues
  – Lack of effective communication with Tier-2’s
  – Lack of a central WLCG operations team
  – Lack of a central body where experiments and sites can take operative decisions
  – Multiple (and sometimes fragile) experiment software installation and runtime configuration systems
  – Poor documentation and logging, difficult configuration for some services
  – Middleware validation with respect to experiments not centrally nor sufficiently organised
Several recommendations given
- Here, only the most important are given
- Recommendations concerning monitoring, network and information system went under the scope of other activities

| Description                                                                 |
|-----------------------------------------------------------------------------|
| Establish a core team for coordinating WLCG operations                      |
| Expand the scope of existing meetings to fully involve Tier-2 sites         |
| Adopt CVMFS to distribute experiment software (and middleware) at sites     |
| Simplify the middleware stack and improve documentation and procedures     |
| Improve middleware distribution and configuration mechanisms               |
| Strengthen the participation of sites and experiments to the commissioning  |
The WLCG operations coordination working group

• Established in October 2012
• Acts as core operations and deployment coordination team
  – Manages operational issues, service deployment in synergy with EGI, OSG, NorduGrid
  – Discusses experiments plans and needs
  – Defines actions and work plans
  – Forms time-limited task forces on specific issues
  – Ensures communication among experiments, sites, projects
• All stakeholders are represented
  – LHC experiments, site regions, Tier-1’s, Grid projects
  – Fortnightly meetings, quarterly planning meetings
  – Largely based on voluntary effort from the entire WLCG community

M. Girone, Operations Coordination Team, 11/07/2012, WLCG GDB
Task Forces review

- CVMFS
- perfSONAR
- SHA-2
- gLExec
- Tracking tools
- Squid monitoring
- FTS 3
- Xrootd
- SL6
- Machine/job features
CVMFS deployment

• A caching, HTTP based read-only filesystem
  – Initially developed by the CernVM project
  – Removes need for local software shared areas
  – Low load, highly scalable, little maintenance effort
  – Adopted by ATLAS in 2011, by LHCb and CMS in 2012, by ALICE this year

• The task force coordinated deployment on all WLCG sites
  – Central repository at CERN, replica at RAL
  – Almost all sites are now running it
  – 2/4 experiments support only CVMFS, the other two close to complete migration
• Evolution of WLCG from hierarchical to mesh model required all network paths to be monitored
  – Need for a WLCG-wide, experiment-independent end-to-end network monitoring to identify problems
  – perfSONAR-PS chosen to be deployed at all sites

• A task force to help sites
  – Installation procedures
  – Definition of tests and metrics
    • Latency, bandwidth, routing, packet loss
  – Centrally managed configurations of “full meshes” of tests

S. Campana et al, Deployment of a WLCG network monitoring infrastructure based on the perfSONAR-PS technology, CHEP2013
SHA-2 deployment

• The SHA-1 hash algorithm currently used to sign Grid certificates is increasingly risky due to known weaknesses
  – The agreed solution is to replace it with SHA-2

• All Grid projects and the International Grid Trust Federation (IGTF) agreed to start using SHA-2 by default from December 2013

• This requires all Grid middleware and experiment services to work with SHA-2
  – The task force coordinates the testing with experiments and projects
  – Almost everything has been verified to work
Adoption of pilot job frameworks requires new mechanisms to allow traceability, user banning and “sandboxing”
- gLExec is such agreed mechanism
- Allows pilot jobs sent with “pilot proxies” to switch to user credentials at runtime
- Needs to be supported by experiment frameworks

The task force coordinates full scale deployment and adoption
- To be finished by end 2013
  - Many sites will deploy it at the same time as SL6
  - Experiments committed to use it by 2014
Tracking tools evolution

• Several ticketing systems in use, with different (and sometime overlapping) scopes
  – GGUS, Savannah, Service Now, JIRA, etc.
• Crucial for effective communication, problem tracking, user support, statistics
• The task force includes experiments, sites, developers and coordinates
  – Commissioning/decommissioning of systems
  – Interfaces between different systems
  – Discussion of new features
• Specific examples
  – Savannah → JIRA migration
  – Savannah → GGUS migration for CMS
Squid monitoring

- Squid caches widely used in WLCG for efficient conditions data access via Frontier and for software distribution via CVMFS
- Needed to harmonise squid installations for different experiments
- The task force integrated Squid monitoring into WLCG common operations
  - Setup of central monitoring pages
  - Monitoring probes, functional tests
  - Registration procedures for GOCDB and OIM, etc.
• File Transfer Service drives the majority of data transfers in WLCG
• Version 3 builds on several years of experience
• Countless improvements
  – Simpler interface, better monitoring, multiple protocols, more DB backends, simpler configuration, ...
  – Much simpler architecture and better scalability (1-2 instances could serve the whole WLCG)
• The task force does integration, testing, validation using pilot services
  – High volume tests already running for ATLAS, CMS and LHCb
  – Goal is delivery of a production service

M. Salichos et al, FTS3 – Robust, simplified and high-performance data movement service for WLCG, CHEP2013
Main goals

- provide support to the xrootd deployment - driven internally by AAA and FAX - and identify common needs
- collect the monitoring requirements and liaise the monitoring effort

Status of deployment strictly connected to the two experiments activities of AAA and FAX
Scientific Linux 6 migration

• Coordinate upgrade to SL6 by minimizing amount of unavailable resources
  – Set a timeline agreed by experiments and set procedures for sites to follow
    • “big bang” vs. rolling upgrades, mixed SL5/SL6 queues, etc.
    • HEP_Oslibs metapackage for experiment software dependencies
    • WLCG repository
  – Make sure experiments are ready
  – Follow and coordinate sites, track status

• Current status:
  – (proto-)Tier-0+1s: 10/16 (now), \(\approx 15/16\) (end October)
  – Tier-2’s: 62% (now), \(\approx 77\%\) (end October)
  – In average, one site every 1.3 days since June without major disruptions to operations
  – Almost all remaining sites should migrate by November
Machine/job features

• Much needed functionality for running jobs
• Static information
  – HS06 rating, no. cores, scratch space, ...
• Dynamic information
  – VM shutdown time, time limits, memory limits, allocated cores...
• The task force is charged with coordinating implementations and deployment in WLCG
  – Including monitoring of the correctness of the information
• First implementations available and tested on physical and virtual hosts
Future challenges (1/2)

• Medium term (during Long Shutdown 1)
  – Monitoring consolidation
    • By dedicated project
  – FTS 2 decommissioning
  – Expanding storage federations
  – Dynamic data placement
Future challenges (2/2)

• Long term (Beyond Long Shutdown 1)
  – Sustainable middleware validation and distribution
  – Full IPv6 compliance
  – New hardware technologies and architectures
  – Full integration of cloud resources
Conclusions

- WLCG Operations successfully work as a collaborative effort.
- Significant progress on several areas.
- Will need to follow the evolution of the infrastructure from an operational perspective in the coming years.
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