QoS Session
WLCG Workshop

Oliver Keeble on behalf of the working group
WLCG Workshop: QoS Session

- Brief Intro
- QoS WG activities
  - Survey
  - White Paper
- Experiment input
- Storage providers
- Discussion
Introduction

• “Quality of Service”
  – A quantitative measure of service performance characteristics
    • Intended to be associated with a cost and a workflow
  – “Unreliable and cheap”, “Fast and expensive”

• QoS is asking questions such as:
  – Are there places in experiment work-flows where it makes sense to trade performance/reliability for increased storage capacity?
  – Are there places in experiment work-flows where a small amount of higher performance storage would yield significant benefits?

• QoS our umbrella term for finding the cheapest possible solution to a given problem (workflow)
  – Concentrating on storage
Introduction

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  - Have you always tried to meet your pledge at the lowest possible cost?
  - Do you wonder how you could deliver your services more cheaply? Or if your users could manage with something different?
  - Do you think this is going to get any easier?

• QoS
  - Is not new
  - Is a new label to group existing efforts

• Now is the time to
  - Give it some more emphasis
  - Coordinate efforts
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    • You will only care more about QoS

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Introduction – an analogy
Introduction
Introduction
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Introduction
Familiar QoS concepts

- **Disk**
  - Huge QoS variations possible under this category
  - All relevant workflows mapped onto this
    - For a particular workflow, can be overspecified in some ways (e.g. reliability) and underspecified in others (e.g. concurrent clients)

- **Tape**
  - Covers both durability and low-cost

  → “Disk”, “Tape”

- **Example additional storage QoS possibilities:**
  - Enterprise HDD as RAID: OUTPUT, REPLICA, COLD
  - Consumer HDD as JBOD: REPLICA
  - (public) cloud storage: COLD
  - SSD as JBOD: FAST
  - Internal replicas existing on multiple server nodes: FAST
The DOMA Working Group
WG Activities

• Site Survey
  - Understand the current and potential QoS landscape

• Experiment Contact
  - Map workflows onto QoS (i.e. onto different systems, reconfigured systems...)

• White Paper
  - A short reference on status and opportunities for cost savings through QoS in WLCG

• Gathering storage provider input

• Contact with other activities: Access WG, Storage Resource Reporting, Cost Modelling ...

• Get involved: sites, experiments and storage providers are very welcome!
  - https://twiki.cern.ch/twiki/bin/view/LCG/QoS

• Egroup: WLCG-DOMA-QoS
  - https://e-groups.cern.ch/e-groups/EgroupsSubscription.do?egroupName=wlcg-doma-qos
Site Survey

- Describe your current system
- Describe your users and use cases
- R&D involvement, future directions
- Will be sent out with example responses filled in by CERN and DESY

- CERN
  - EOS erasure encoding, Server hardware configuration, Tactical deployment of SSDs, Tape backends …

- DESY
  - …
Experiment Input
ALICE - two QoS types in the future (same as today)

- **Disk** - primary holder of analysis objects
  - No use case for complicated disk structures
  - Current implementation is OK - the size of the site (CPU) and nearby SE I/O performance are usually matching well
  - In very special cases (Analysis Facility) - direct negotiation with the site providing the AF

- **Custodial (@present=Tape)**
  - Single instance of RAW data and replica of the reco/MC output
  - Strictly controlled recall/access
  - SSD caches as tape buffer are very interesting concept

- **The trend** - software configurable storage, inexpensive hardware (JBODs, no hardware RAID, no special FS)
  - ALICE is fully on board with this
  - Sites manage the infrastructure, combined storage (aka ‘data lakes’) for close and well connected sites is working and we support it through the ALICE DM system
Rucio & QoS Short Summary

```
rucio add-rule my.dataset copies=2 country=UK lifetime=1w qos=cheap-med-latency
rucio add-rule my.dataset copies=2 country=UK lifetime=1w qos={latency:<100, cost:<1000}
```

What is important for us?

- Common language for the definition of QoS classes and QoS properties
- Common API + data structure to ask for for QoS transition
- QoS capabilities and zones from each storage need to be published and kept up to date
  - Rucio needs to know in which QoS zone the data is for internal scheduling
- Storage can automatically transition between "lower" QoS properties, but must never exceed constraint
  - e.g., move between cheaper zones without affecting combined cost and latency constraint
  - Must notify Rucio when such a transition happens
- Rucio would continuously check all QoS constraints at the rule level
  - Request transitions as necessary to keep rules satisfied
Some (very initial) Thoughts on QoS

We understand QoS as an intend by sites

- Are there plans to monitor and verify the promised QoS? Who?

Some possible QoS classes:

<table>
<thead>
<tr>
<th>Archival</th>
<th>High I/O Disk</th>
<th>Resilient Disk</th>
<th>Non-redundant Disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Long term archiving</td>
<td>- Fast spinning disk</td>
<td>- Medium I/O</td>
<td>- Medium I/O</td>
</tr>
<tr>
<td>- Minimal data losses</td>
<td>- SSD</td>
<td>- RAID or duplication</td>
<td>- Maximum capacity per cost</td>
</tr>
<tr>
<td>- Understood recall rates</td>
<td>- Capability to serve most demanding</td>
<td>- Site attempts recovery of files</td>
<td>- Experiment recovers (expected) file losses</td>
</tr>
<tr>
<td></td>
<td>Workflows</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Pileup Mixing</td>
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</tbody>
</table>

Presently Tape

Presently Disk (not distinguishing any QoS)

Other relevant QoS metrics

- WAN connectivity: at least coarse classification (1Gb/s, 10Gb/s, 100Gb/s)

- Minimum effective read size
  - CMS application sends vectors of many smallish read requests
  - Too large minimum read sizes lead to good throughput, but still inefficient applications
QoS appears through the “Service class”.
- In LHCbDirac: configuration linked with operational requests. No software definition

T1D0: used for archive, this very precious data.
- Operationally 2 replicas for RAW data but only 1 for other (derived) datasets
- Heavy task to reproduce derived dataset in case of loss => high reliability required

T0D1: used for 3 purposes
- Datasets for physics: usually >1 disk replica + 1 archive => loss is not a disaster, can be recovered
- Temporary datasets (before further processing/merging): a single replica with life time of a few days => loss created operational complications, although re-creation is possible but painful
- User private data (e.g. nTuples): usually 1 disk replica, can be re-created with operational complications (users are less experienced). Also used for input sandboxes, this availability is usually a problem (jobs cannot run if SB is unavailable)

T0D2 : EOS @ T0

Possible improvements
- New class with very high QoS for temporary data (also for user data?)
- Important: New classes should be available through separate endpoints or explicit prefixes
Storage Systems
Storage Systems

• Storage Systems' QoS support generally already exceeds what we currently use in WLCG
  - All support pools with different media types
    • Most distinguishable by prefix
  - All support multi replica either natively or through the backend system
  - Almost all support multi-site operation
  - Most have hierarchical support with potentially automated QoS transitions
    • Including tape backends
  - Some have volatile or caching modes of operation
  - Some support CDMI, an interface extendable with support for QoS operations

• What's missing?
  - Production-grade QoS Management interface (but do we need it?)
Discussion
Discussion points

- Is a new “contract” desirable/possible between sites and experiments?
  - What characteristics do we care about? (i/o, durability, ...)
  - Does the pledge system need a review?
  - How would new QoS classes be validated?

- What are sites interested in trying?

- What technology should we be reviewing?

- How can the experiments adapt their workflows to exploit QoS savings?

- What QoS transitions on a single system are desirable?
  - Is a community discussion required for a post-SRM tape interface?

- What other QoS initiatives are there (Escape)?

- What should the WG be concentrating on?