Long-Term Sustainability
A User (Support) View

EOSC Pilot: Science Demonstrator
Jamie.Shiers@cern.ch

Slides available at https://indico.cern.ch/event/643419/
• Robust, stable services over several decades
• Data preservation and re-use over similar periods
• “Transparent” and supported migrations

Database / data management support, CERN Program Library, Distributed Computing

DM R&D, DBs, WLCG, EGI Major Data Migrations(!)

ESFRI roadmap as “landmark project”
“Data Preservation” Demonstrator

- Goal is to demonstrate “best practices” regarding data management and their applicability to LTDP + “open” sharing + re-use
  - PIDs for data & meta-data stored in TDRs;
  - DOIs for documentation;
  - S/W + environment.

- Equivalent to CERN Open Data Portal but using “open” – i.e. non-HEP – solutions
  - These all exist and are “advertised” in some form
    - But there are “questions” around: Services; Resources; Long-Term Support (& Migration)…
    - As well as Cost of Entry / “Ownership”

# Example Services – LTDP

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<th>Service</th>
<th>HEP</th>
<th>Non-HEP</th>
<th>Issues</th>
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<td>Trustworthy DR</td>
<td>CERN CASTOR+EOS (ISO 16363)</td>
<td>EUDAT (?) (DSA / WDS)</td>
<td>How to get access to even modest resources?</td>
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<td>PID / DOI systems</td>
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<td>“Long-term” support; availability of services</td>
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<td>Digital Library</td>
<td>CERN Document Server, INSPIRE-HEP <em>(Invenio-based)</em></td>
<td>B2SHARE, Zenodo <em>(Invenio-based)</em></td>
<td>CERNLIB documentation example (20 years)</td>
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<td>Software + Environment (+build system)</td>
<td>CVMFS, CernVM</td>
<td>Ditto</td>
<td>“Software without environment is just bad documentation”</td>
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- For a user (community) to go “shopping around” to find the right services, resources and support is a (major?) challenge / impediment
- More (and more complex) services needed to support data processing, distribution and analysis (full data lifecycle=WLCG4LHC)
**What is (HEP) data?**

(And its not just “the bits”)

**Digital information**
The data themselves, volume estimates for preservation data of the order of **a few to 10 EB**

Other digital sources such as databases to also be considered

**Software**
Simulation, reconstruction, analysis, user, in addition to any external dependencies

**Meta information**
Hyper-news, messages, wikis, user forums..

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**Publications**
arXiv.org

**Inspire**

**Journal of High Energy Physics**
A refereed journal, written, run and distributed by electronic means

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**Documentation**
Internal publications, notes, manuals, slides

**Expertise and people**
User requirements / expectations

• (Large) user requirements often exceed available resources / budgets (and existing resources typically fully utilised)
  ➢ Negotiation phase to converge

• Service expectations (e.g. max 10’ downtime) quasi-impossible to achieve
  ➢ Focus on response targets, critical services and reporting metrics

• Regular operations meetings de-fuse situations before they arise

• How to scale these “solutions” to large numbers of communities in an EOSC?
  • Community-based support, e.g. for ESFRIs, probably needed
  ➢ WLCG could be a successful model to look at
The Worldwide LHC Computing Grid

October 2016:
- 63 MoU’s
- 167 sites; 42 countries
- Tier0, Tier1s & Tier2s
- $O(1)$, $O(10)$, $O(100)$

CPU: 3.8 M HepSpec06
- If today’s fastest cores: ~ 350,000 cores

Disk 310 PB

Tape 390 PB

Don’t under estimate the scale of the problem!

Building a production grid at the scale of WLCG took the best part of a decade (and a significant amount of investment, including from EU)

Running jobs: 441,353
Active cores: 630,003
Transfer rate: 35.32 GiB/sec
WLCG Service Challenges

- As much about people and collaboration as about technology
  - Getting people to provide a 24 x 7 service for a machine on the other side of the planet for no clear reason was going to be hard!
- Regional workshops – both motivational as well as technical – plus daily Operations Calls
- In a grid, something is broken all of the time!
- Clear KPIs, “critical services” & response targets: measurable improvement in service quality despite ever increasing demands

Targets for response, intervention and resolution based on severity. Monitored regularly – *not guarantees!*
DMPs, the EOSC and ESFRIs

- An EOSC must support **multiple disciplines**
  - Therefore, we need a *lingua franca* i.e. someway of getting them to talk together
    - And / or to the service providers!

- **IMHO, DMPs could provide just that!**
  - Even though guidelines would need to be broadened to cover data acquisition, processing, distribution and analysis in more detail!
  - DMP w/s for ESFRI(-like) projects proposed: to be rescheduled now that EOSC goals / plans more clear

Synergies through DMPs: save time, money; better solutions!
Benefits of collaboration: LTDP

1. The elaboration of a clear "business case" for long-term data preservation
2. The development of an associated "cost model"
3. A common view of the Use Cases driving the need for data preservation
4. Understanding how to address Funding Agencies requirements for Data Management Plans

Collaboration (and not “control”) is key to everything CERN does.
Director Generals’ Viewpoints

- Software/Computing should not limit the detector performance and LHC physics reach
- the Software must be easy-to-use and stable
- not to hinder the fast delivery of physics results (and a possible early discovery …)

To find the Higgs you need the Accelerator, the Detectors and the Grid!

CHEP 2004, Interlaken

“Higgs discovery day”, CERN, 2012
Services are (just) services

- No matter how fantastic our { TDRs, PID services, Digital Library, Software repository } etc is, they are there to support the users

- Who have to do the really hard work!
  - E.g. write the software, documentation, acquire and analyse the data, write the scientific papers

- Getting the degree of public recognition as at the Higgs discovery day was a target KPI!
~30 years of LEP – what does it tell us?

- Major migrations are **unavoidable** but hard to **foresee**!

- **Data** is not just “**bits**”, but also **documentation, software + environment + “knowledge”**
  - “**Collective knowledge**” particularly hard to capture
  - Documentation “refreshed” after 20 years (1995) – now in Digital Library in PDF & PDF/A formats (was Postscript)

- Today’s “**Big Data**” may become tomorrow’s “**peanuts**”
  - 100TB per LEP experiment: **immensely challenging** at the time; now “trivial” for both CPU and storage
  - With time, **hardware costs** tend to zero
    - $O(CHF\ 1000)$ per experiment per year for archive storage
  - **Personnel costs** tend to $O(1FTE) >> CHF\ 1000!$
    - Perhaps as little now as 0.1 – 0.2 FTE per LEP experiment to keep data + s/w alive – no new analyses included

See DPHEP Workshop on “Full Costs of Curation”, January 2014:
https://indico.cern.ch/event/276820/
A triple migration!
- Data format and software conversion from Objectivity/DB to Oracle
- Physical media migration from StorageTek 9940A to 9940B tapes

Took ~1 year to prepare; ~1 year to execute

Could never have been achieved without extensive system, database and application support!

Two experiments – many software packages and data sets
- COMPASS raw event data (300 TB)
  - Data taking continued after the migration, using the new Oracle software
- HARP raw event data (30 TB), event collections and conditions data
  - Data taking stopped in 2002, no need to port event writing infrastructure
In both cases, the migration was during the “lifetime” of the experiment
System integration tests validating read-back from the new storage
Open Science: A 5-Star Scale?

- We have a 5-star scale for Open Data
  - Sir Timothy Berners-Lee

- We have a proposed 5-star scale for FAIR data management (+TDRs)
  - Peter Doorn and Ingrid Dillo

- How about a 5-star scale for “Open Science: Open to the World”?  
  - The EOSC

“Open to the world” cannot mean no accounting, authorisation, access control etc.
What are the right metrics?

- As easy to use as Amazon?
- Cheaper (and better) than doing it in-house?
- A majority of ESFRIs use it as their baseline?

➢ “To find dark matter, you need the EOSC”?
“Data Preservation” Demonstrator

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“Data” Preservation in HEP

- The data from the world’s particle accelerators and colliders (HEP data) is both **costly** and **time consuming** to produce.

- HEP data contains a wealth of **scientific potential**, plus high value for **educational outreach**.

- Many data samples are **unique**, it is essential to preserve not only the data but also the full capability to reproduce past analyses and perform new ones.

- **This means preserving data, documentation, software and "knowledge".**

Requires different (additional) services (resources) to those for analysis.
What Makes HEP Different?

• We **throw away** most of our data before it is even recorded – “triggers”
• Our detectors are **relatively stable** over long periods of time (years) – not “doubling every 6 or 18 months”
• We make “**measurements**” – not “**observations**”
• Our projects typically last for **decades** – we need to keep data usable during at least this length of time
• We have **shared** “data behind publications” for more than 30 years… (**HEPData**)
CERN Services for LTDP

1. State-of-the art "bit preservation", implementing practices that conform to the ISO 16363 standard
2. "Software preservation" - a key challenge in HEP where the software stacks are both large and complex (and dynamic)
3. Analysis capture and preservation, corresponding to a set of agreed Use Cases
4. Access to data behind physics publications - the HEPData portal
5. An Open Data portal for released subsets of the (currently) LHC data
6. A DPHEP portal that links also to data preservation efforts at other HEP institutes worldwide.

These run in production at CERN and elsewhere and are being prototyped (in generic equivalents) in the EOSC Pilot

Humble pie: services are just services. The real work is in using them!
Bit Preservation: Steps Include

- **Controlled media lifecycle**
  - Media kept for 2 max. 2 drive generations
  - Regular media verification
    - When tape written, filled, every 2 years…
  - **Reducing** tape mounts
    - Reduces media wear-out & increases efficiency
- **Data Redundancy**
  - For “smaller” communities, a 2nd copy can be created: separate library in a different building (e.g. LEP – 3 copies at CERN!)
  - **Protecting** the physical link
    - Between disk caches and tape servers
  - **Protecting the environment**
    - Dust sensors! (Don’t let users touch tapes)

**Constant improvement: reduction in bit-loss rate: 5 x 10⁻¹⁶**

See “The Lost Picture Show: Hollywood Archivists Can’t Outpace Obsolescence” IEEE Spectrum
LTDP Conclusions

• As is well known, Data Preservation is a Journey and not a destination.

• Can we capture sufficient “knowledge” to keep the data usable beyond the lifetime of the original collaboration?

• Can we prepare for major migrations, similar to those that happened in the past? (Or will x86 and Linux last “forever”)

• For the HL-LHC, we may have neither the storage resources to keep all (intermediate) data, nor the computational resources to re-compute them!

➤ You can’t share or re-use data, nor reproduce results, if you haven’t first preserved it (data, software, documentation, knowledge)
From LEP (1989 – 2000) to the LHC (2009 – 2035) to the “FCC”

“Big data” from hundreds of TB to hundreds of PB to (perhaps) hundreds of EB

• FCC-ee option: “repeat” LEP in just 1 day!

• FCC-hh: 7 times LHC energy, $10^{10}$ Higgs bosons

More on Physics Case and technical options in May 2017 CERN Courier!