

Long-term preservation of analysis software environment

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Challenge : How to reprocess experiment data in 25 years, using old software version?

In year 2037, new results are contradicting your 2012 results. Is the problem with the software, or with the detector? And is it the new or the old results which are correct? You want to investigate the source of the discrepancy. The old data are still accessible, and you have all software versions in the SVN. You check out the old version, but it does not compile on your modern computer. Wrong compiler. Wrong libraries. You try to install an old OS on your computer, but the modern hardware is not supported. And old hardware does not exist any more. The only option left seems to be to port the code to a modern OS. But this will take lots of time, and may not produce the same results. What do you do?

CernVM Virtual machine

A dedicated **distribution** of Linux, CernVM, is developed for deployment of virtual machines (VMs). It is based on Scientific Linux 5, and supports all popular hypervisors. Updated versions will be made available for new software, while older versions will be available for legacy analysis software.

The image size has been kept small (300MB) by only providing essential software; analysis software is provided via CVMFS. There are four spins targeting specific use cases: cluster head/batch node and developer desktop/basic. A key point is to offer developers a virtualised desktop environment very similar to the batch environment where jobs will run, thus reducing the likelihood of failing jobs. CernVM offers several methods of contextualisation, depending on the use case. For batch systems, an Amazon EC2 compatible interface is provided for full experiment/site customisation.

CernVM-based data preservation

Fortunately, you migrated the development and processing to CernVM and CVMFS in 2012. Binaries for all versions of your software already exists, readily accessible through CVMFS. Also, all versions of CernVM are preserved. You log in to your CernVM data bookkeeping web interface, and select the 2012 data for processing, using both the 2037 and the legacy 2012 version of the software, on matching legacy CernVM versions.

Next morning the processing is finished, and you can start finding out where the discrepancy is introduced. Using the legacy CernVM version, you also have an environment to recompile the old software version, if modifications are needed.

A **bookkeeping** system is needed to keep track of the properties of experiment data collected, as well as the processing status. For a HEP experiment, this may include run number, time, beam energy, target type, reconstruction software version, path to raw and processed data, etc.

There are several web interfaces available for managing virtual machines, and for launching VMs. However, there are few, if any, interfaces which combine these two aspects. Such user interface would allow the user to select data matching certain criteria for reprocessing. Subsequently, the user may select software version, matching OS version, number of processing nodes, node configuration (e.g. RAM). At the submission of the job, an on-demand virtual cluster will be created, matching the specifications. Upon completion, the cluster may be recycled for further processing tasks, or destroyed. The VMs will be managed through the EC2 interface.

CernVM Data bookkeeping

CernVM File system



CernVM file system (CVMFS) is a globally **distributed file system** based on the HTTP protocol. A repository is set up on a central server, with an hierarchy of HTTP proxy servers for load distribution. Each computing centre will have its own proxy.

For all files, a hash is calculated, and the file compressed. The compressed file is stored in a HTTP file storage under its hash. Hence, file duplication is avoided. The hash and the directory structure of the repository is stored in a data base file. The clients will download this DB and use it for directory look-up. When a file is needed, the compressed file is downloaded from the proxy to a local cache. Files are typically not removed from the cache, i.e. only downloaded once. The proxy server will automatically download requested files it does not possess itself. Hence, no need for local software installation.

Cloud infrastructure is a prerequisite for virtualised computing facilities. While the relative effort of setting up such infrastructure may be negligible for a large tier 0 or 1, it may be substantial for a small Tier 2 or 3 with limited resources. To ease the deployment effort for Tier 2 and 3, a reference cloud has been set up. It is based on Scientific Linux 6, OpenNebula (a popular framework for cloud deployment), and KVM/QEMU (a Linux hypervisor).

OpenNebula supports the Amazon EC2 interface, allowing it to behave both as an EC2 cloud as well as to launch VMs on another EC2-compatible cloud infrastructure. Detailed step-by-step instructions will allow sites to replicate the reference cloud with limited effort. The site may choose to either allow its resources to be part of a larger cloud through the EC2 interface (bypassing grid middleware), or launch VMs to process jobs directly themselves (using grid middleware).

CernVM Reference cloud



Status

Both CernVM and CVMFS are currently used by many LHC and other experiments for production. CVMFS is also used by a number of non-virtualised computing centres for software distribution. The reference cloud and the data bookkeeping user interface represent new development to the CernVM family. The reference cloud is set up, but not production ready. The development of the bookkeeping interface is in an early stage. Production systems are expected by the end of the year.

Resources and further reading

1. The CernVM home page: <https://cernvm.cern.ch>
2. CernVM - a virtual appliance for LHC applications: <http://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=70>
3. CernVM: Minimal maintenance approach to the virtualization: <http://iopscience.iop.org/1742-6596/331/5/052004>
4. A practical approach to virtualization in HEP: <http://dx.doi.org/10.1140/epjp/i2011-11013-1>

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