CernVM - Virtual Machine for LHC Experiments

Predrag Buncic (CERN/PH-SFT)
Background

• Over the past couple of years, the industry is silently redefining the meaning of some familiar computing terms
  ▪ Shift from glorious ideas of a large public infrastructure and common middleware towards end-to-end custom solutions and private corporate grids
• New buzzwords
  • Amazon Elastic Computing Cloud
    – Breakthrough in industry approach to computing
    – Everything is for rent (CPU, Storage, Network, Accounting)
  • Blue Cloud (IBM) is coming
  • Software as a Service (SaaS)
  • Google App Engine
  • Virtual Software Appliances and JeOS
• In all this cases, *virtualization* is emerging as a key enabling technology
• Trend supported by CPU manufacturers
  ▪ Multiple cores
  ▪ Hardware virtualization (Intel VT, AMD-V)
Motivation

- **Software @ LHC Experiment(s)**
  - Millions of lines of code
  - Complicated software installation/update/configuration procedure, different from experiment to experiment
  - Only a tiny portion of it is really used at runtime in most cases
  - Often incompatible or lagging behind OS versions on desktop/laptop

- **Multi core CPUs with hardware support for virtualization**
  - Making laptop/desktop ever more powerful and underutilised

- **Using virtualization and extra cores to get extra comfort**
  - Zero effort to install, maintain and keep up to date the experiment software
  - Reduce the cost of software development by reducing the number of compiler-platform combinations
  - Decouple application lifecycle from evolution of system infrastructure
How do we want to do that?

• Build a “thin” Virtual Software Appliance for use by the LHC experiments

• This appliance should
  ▪ provide a complete, portable and easy to configure user environment for developing and running LHC data analysis locally and on the Grid
  ▪ be independent of physical software and hardware platforms (Linux, Windows, MacOS)

• This should minimize the number of platforms (compiler-OS combinations) on which experiment software needs to be supported and tested, thus reducing the overall cost of LHC software maintenance.

• All this is to be done
  ▪ in collaboration with the LHC experiments and OpenLab
  ▪ By reusing existing solutions where possible

• Resources
  ▪ 7.5 FTE (staff) + 7.5 FTE (fellow) over 4 years
From Application to Appliance

http://www.rpath.com
Groups & Builds

Build types

- Installable CD/DVD
- Stub Image
- Raw Filesystem Image
- Netboot Image
- Compressed Tar File
- Demo CD/DVD (Live CD/DVD)
- Raw Hard Disk Image
- Vmware® Virtual Appliance
- Vmware® ESX Server Virtual Appliance
- Microsoft® VHD Virtual Appliance
- Xen Enterprise Virtual Appliance
- Virtual Iron Virtual Appliance
- Parallels Virtual Appliance
- Amazon Machine Image
- Update CD/DVD
- Appliance Installable ISO
- Sun VirtualBox Image
“Thin” Software Appliance

JeOS (based on rPath Linux)

LAN/WAN (HTTP)

Cache

Software Repository

0.1 GB 1 GB 10 GB

CERN, 18/06/2008 - 7
Reusing existing tools

On same host:

```
/app
```

```
/opt/lcg
-> /chirp/localhost/opt/lcg
```

```
App
```

```
open("/opt/lcg")
```

```
Kernel
NFS LFS FUSE
```

```
!Cache
```

```
Chirp Fuse
```

```
Parrot
```

```
Cache
```

On File Server

```
/opt/lcg
-> /grow/host/opt/lcg
```

```
Chirp server
```

```
open("/opt/lcg")
```

Parrot is part of Cooperative Computing Tools
http://www.cse.nd.edu/~ccl/software/
Alpha release 0.5

- Available for download from
  - [http://rbuilder.cern.ch/project/cernvm-devel/releases](http://rbuilder.cern.ch/project/cernvm-devel/releases)
- Can be run on
  - Linux (Xen, VMware Player)
  - Windows (VMware Player)
  - Mac (Fusion, Parallels)
- Release Notes
- HowTo
  - [http://cernvm.web.cern.ch/cernvm/?page=HowTo](http://cernvm.web.cern.ch/cernvm/?page=HowTo)
- Limited testing to verify that appliance can be configured and used with Alice, LHCb, ATLAS (and CMS) software frameworks
  - Thanks to Yushu Yao (ATLAS), Dimitrije Maletic (CMS) and Marco Clemencic (LHCb) for help in installing the experiment software and debugging problems
SLC4 Compatibility

- Not an issue for ALICE
  - They provide a consistent set of dependencies down to gcc level
  - Framework directly depends only on ROOT
- No big problems with ATLAS
  - Requirements to allow flexible cache management (cernvm-cache)
- No feedback from CMS
  - Their approach is similar to ALICE, no big problems expected
- Number of requests from LHCb
  - xauth added to allow users to use ssh -X (or ssh -Y) to forward X11 sessions
  - vim, less and mc packages added to group-cernvm-devel
  - kbdconfig tool to select keyboard layout added to group-base
  - added SLC3 compatibility libraries for gcc 3.2.3
  - added SLC4 compatibility libraries
    - db4, readline, openssl, tcl, tk, libxml2
New package group structure

- **group-cernvm** (core packages)
- **group-cernvm-devel** (development tools)
- **group-slc4** (SLC4 compatibility libs)
- **group-<experiment>**
  - groups and extra packages required by experiment

100 MB

- compat-db4
- compat-openssl
- compat-linstdc++slc3
- compat-libxml2
- compat-readline
- compat-tcl
- compat-tk
CernVM File System

On same host:

```
/App
open("/opt/lcg")
```

```
/CernVM
Fuse
```

```
/Kernel
NFS LFS FUSE
```

```
/Cache
```

On File Server

```
/opt/lcg
-> /chirp/localhost/opt/lcg
```

```
/opt/lcg
-> /grow/host/opt/lcg
```

Roadmap

• Release 0.6 (30/06/08)
  ▪ Bug fixes
  ▪ Adding missing packages and features based on feedback from experiments
    ▪ Addressing SLC4 binary compatibility issues (new package group structure)
• Release 0.7 (04/08/08)
  ▪ Write access to software repository
    • Allowing experiments to publish their releases
  ▪ Support for x86_64 platform
• Release 0.8 (01/09/08)
  ▪ New (simplified and improved) file system
• Release 0.9 (29/09/08)
  ▪ Bug fixes
• Release 1.0 (03/11/08)
Other interesting projects

• BOINC
  ▪ Open-source software for volunteer computing and grid computing
  ▪ CernVM is now extended to include BOINC client
  ▪ Summer student project in OpenLab
    • based on LHC@HOME experience and CernVM image to run ATLAS simulation using BOINC infrastructure
  ▪ http://boinc.berkeley.edu/

• Globus Virtual Workspace Service
  ▪ An open source infrastructure for the deployment and management of virtual machines
  ▪ Google Summer School (hosted at ANL) project to deploy a one-click, auto-configuring virtual Grid overlay for Alice/AliEn
  ▪ http://workspace.globus.org/
Mailing lists

- cernvm-talk@cern.ch (Open list to discuss about design, user experience and related issues with the CernVM project)
- cernvm.support@cern.ch (End-user support for the CernVM project)

Savannah Portal

- Please submit bugs and feature requests to Savannah at
  - http://savannah.cern.ch/projects/cernvm

Web site(s)

- http://cernvm.cern.ch
- http://rbuilder.cern.ch