Towards a production volunteer computing infrastructure for HEP

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Presentation on behalf the CERN BOINC Service Team
# Why Volunteer Computing?

| Target                          | Deployment                  | Benefit                                                                 |
|--------------------------------|-----------------------------|-------------------------------------------------------------------------|
| Volunteers                     | Uncoordinated, opportunistic| • Get additional, “free” compute cycles                                |
|                                |                             | • Engage with communities outside HEP: outreach and publicity for HEP and science |
| Institute desktops             | Coordinated, opportunistic  | • Get additional, “free” compute cycles                                |
| Small to midsize server farms  | Coordinated, pledged        | • Easier to deploy than complete Grid middleware                        |
Infrastructure / Middleware

• Most commonly used middleware: BOINC
  – Other choices: XtremWeb, HTCondor, …
  – Other initiatives based on virtualisation and clouds
    (e.g: CernVM web-api talk at recent CernVM workshop)

CERN has adopted BOINC for VC projects
  (LHC@home)
BOINC

• Software platform for distributed computing using volunteered computer resources
• Client – server architecture
• Free and open source
• Used for:

SETI@home
Climateprediction.net
Einstein@home
LHC@home

...
BOINC – Volunteer view

• Download and run BOINC client
• Choose a project
• Provide email and password to the BOINC Manager
  (alternatively make a silent connection with a key from the BOINC client)
• Done, crunching can start!

1. get instructions
2. download applications and input files
3. compute
4. upload output files
5. report results
BOINC Compute Power

| Project                          | Average power |
|---------------------------------|---------------|
| Seti@home                       | 695 TFlops    |
| Einstein@home                   | 680 TFlops    |
| World Community Grid            | 504 TFlops    |
| LHC@home -classic               | 32 TFlops     |
| Virtual LHC@home                | 3.4 TFlops    |

According to BOINCstats.com 4.3.2015
Virtualisation in BOINC - 1

• Pioneered at CERN in 2010-2011 by Test4Theory and the CernVM team in PH/SFT
• Later brought into BOINC mainstream code as “Vboxwrapper”
  – Ref: http://boinc.berkeley.edu/trac/wiki/VboxApps
  – BOINC developers very helpful with improvements

• Besides CERN (Theory, Atlas, CMS, LHCb) there are several other BOINC projects now deploying Virtualisation:
  RNAword, Climateprediction.net, CAS@home
Virtualisation in BOINC - 2

- BOINC distributes VMs to client machines along with a wrapper application
- The BOINC client installation for Windows now includes Virtual Box
**BOINC: Classic vs Virtualisation**

| Classic BOINC | Virtualisation |
|---------------|----------------|
| • Applications are native binaries  
• Unknown environment  
• Multitude of OS  
• Application building/testing and result verification is very labour-intensive | • Applications run in a VM  
• Typical hypervisor; VirtualBox (installed with BOINC on some OS)  
• Application to be built for one environment only |
| • BOINC takes care of job management  
• Local application framework must be integrated with BOINC | • BOINC takes care of distributing VM image  
• External job manager possible |
LHC@home - Sixtrack

• Started as outreach project for CERN’s 50th anniversary 2004, used for Year of Physics (Einstein Year) 2005
  – Based on experience from the Compact Physics Screen Saver (CPSS), which ran SixTrack on desktop computers at CERN

• Calculates stability of proton orbits in the LHC accelerator
• Written in FORTRAN, simulates particle trajectories
• Uses the classic BOINC approach
• Client runs on Linux, Mac and Windows platforms
• Renewed effort for LHC upgrade studies (HL-LHC)
• Total 118’000 volunteers, about 20’000 active recently
• Compute power: Peak 45 TFlops, average 13 TFlops
LHC@home - Test4Theory

• Launched 2011 in partnership with the Citizen Cybercience Centre – CCC
• Theoretical fitting of all past experimental data (including LHC) using Monte Carlo simulation based on Standard Model
• Pioneered use of Virtualisation with BOINC
• Job reads data from CernVMFS
• External job management: CoPilot (being phased out)
• CernVM, CernVMFS, CoPilot: developed by CERN (PH-SFT)
• Wide range of potential (physics) applications

Project changed name in 2014 to Virtual LHC@home
Virtual LHC@home

• Total of 1.7 trillion events simulated since 2011
• Source: MC Plots (http://mcplots-dev.cern.ch/production.php)
• See also: http://cern.ch/go/9nRz
LHC@home – LHC experiments

ATLAS
• started early 2014 as internal pilot, now public
• using μCernVM and virtualisation

CMS
• started work in summer 2014
• prototype running, rapidly gaining experience

Listen to the next two contributions in this track

LHCb (Beauty)
• prototyping started in 2012
• Currently fed by volunteers inside the collaboration
BOINC contribution to ATLAS

Slots of Running Jobs
662 Hours from 2015-02-03 to 2015-03-03 UTC

http://cern.ch/go/4tjG

Maximum: 112,630, Minimum: 0.00, Average: 63.358, Current: 62,935
BOINC contribution to ATLAS

BOINC is the 2nd largest simulation site
Running 4-5k parallel jobs

BNL-ATLAS
BOINC
RAL-LCG2
IN2P3-CC
INFN-T1
UKI-LT2-BRUNEL
CERN-PROD
...
CERN BOINC Service

Server cluster
- LHC@home servers in production (Sixtrack, Theory, ATLAS)
- Test servers – used as dev/prototyping environments by the projects

Server application support
- Configuration, monitoring
- MySQL database server back-end
- BOINC server application configuration and updates

Website framework (http://cern.ch/LHCathome)
- common [Drupal portal](http://example.com), as entry point for all BOINC projects and applications hosted at CERN
We are not involved in the R&D and outreach aspects specific to the projects. So the corresponding teams deal with:

- Porting of applications to BOINC
- Application-specific job management framework
- Communication/outreach with volunteers about science involved
- Management of user forums and project material in the portal
Service evolution

- VM applications that report back to a local job management framework can be part of Virtual LHC@home.
- Other (Sixtrack, ATLAS) are currently hosted on separate servers to avoid I/O bottleneck.
- Aim for standardisation on a volunteer cloud common job management solution (Data Bridge, more at the CMS talk).
BOINC - use cases for HEP

Desktop - BOINC client with BOINC manager
- Individual BOINC user like for volunteers among the general public
- Or generic institute BOINC user for central deployment (desktop grid)

Small clusters - BOINC client and virtual box
- Install RPMs, provide startup script to run the BOINC client, generic BOINC user

Larger clusters (e.g. small Tier-2 centers)
- Like above, configured centrally, e.g. with Puppet

Tier-2 with local grid storage
- No grid credentials on VMs distributed with BOINC to access local storage
- Launching VMs with VAC or VCycle may be more appropriate
Conclusions

• Volunteer computing offers a lightweight way to distribute jobs
• BOINC is the de-facto standard middleware for volunteer computing
• Thanks to virtualization support, BOINC is now suitable for a wider range of HEP applications
• Applications running under CernVM and getting data from CernVMFS can be hosted as part of LHC@home
• The size of the application data sets remains a bottle neck
• Outreach and communication is essential to get contributions from the general public
• Desktops and other opportunistic local resources offer capacity that can be exploited
This is the joint work of many people...

- BOINC service: Nils Hoimyr, Pete Jones, Tomi Asp, Alvaro Gonzalez
- Also Miguel Marquina, Helge Meinhard, Manuel Guijarro, Ignacio Reguero
- Test4Theory: Ben Segal, Peter Skands, Jakob Blumer, Ioannis Charalampidis, Artem Harutyunyan, Predrag Buncic, Daniel Lombrana Gonzalez, Francois Grey et al
- Sixtrack: Eric McIntosh, Riccardo de Maria, Massimo Giovannozzi, Igor Zacharov et al
- ATLAS: David Cameron, Andrej Filipic, Eric Lancon, Efrat Tal Hod, Wenjing Wu
- CMS: Laurence Field, Hendrik Borras, Daniele Spiga, Hassan Riahi, Ivan Reid
- LHCb: Federico Stagni, Joao Medeiros, Cinzia Luzzi et al
- BOINC: David Anderson, Rom Walton
- and many CERN colleagues offering the underlying layered services
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