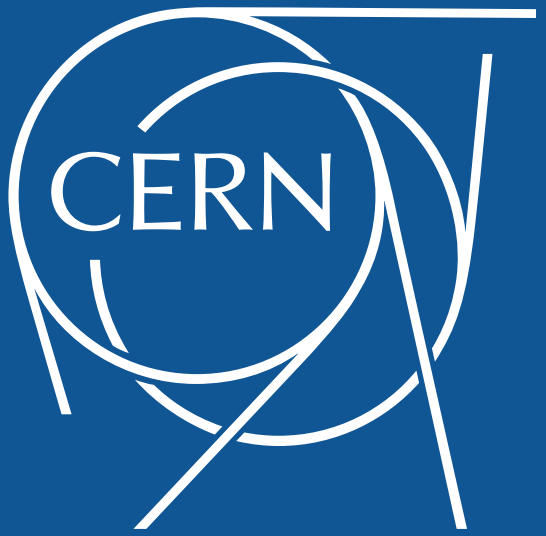

CERN

Volunteer Clouds for the LHC experiments

Laurence Field
Hassen Riahi

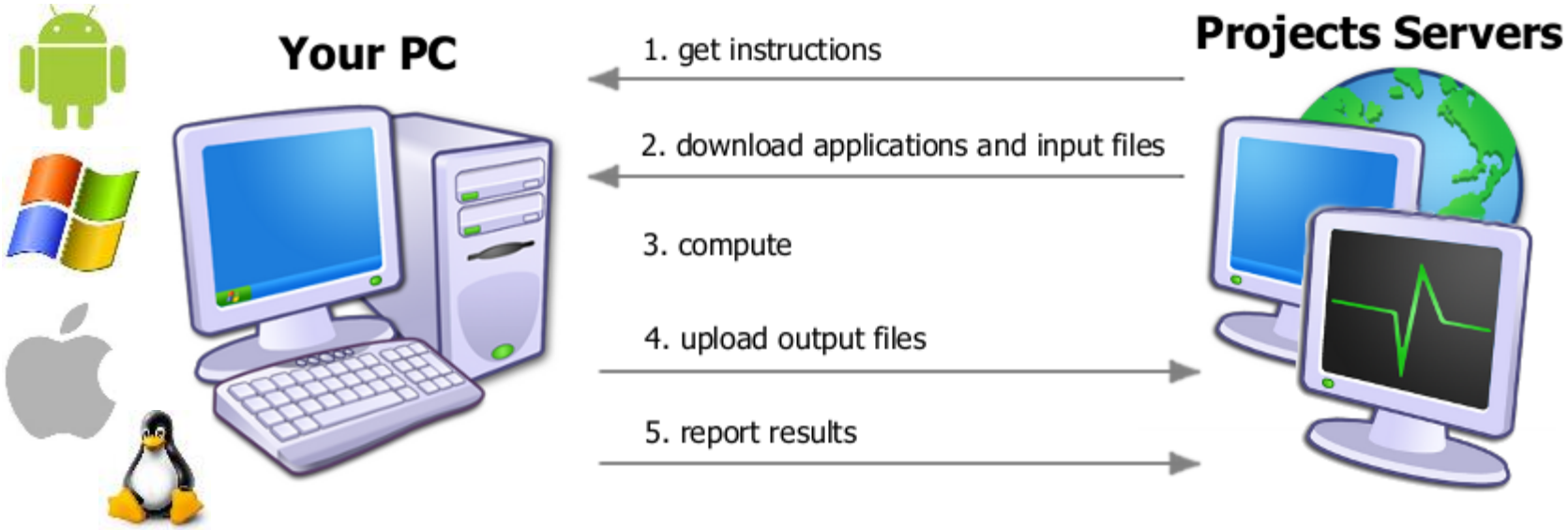
CERN IT-SDC

Volunteer Computing

- A type of distributed computing
- Origins in mid 1990s
- Computer owners *donate* computing capacity
  - To a *cause* or project
- Not necessarily only spare cycles on desktops
  - Idle machines in data centers
  - Home clusters
- Berkeley Open Infrastructure for Network Computing (**BOINC**)
  - Started in 2002
  - Funded by the National Science Foundation (NSF)
  - SETI@home: 12K Active Users, 16K Active Hosts
  - In 2007, IBM World Community Grid switched to BOINC
    - 67K Active Users, 1.8M Active Hosts

Volunteer Perspective

- Download and run BOINC software
- Choose a project
- Enter an email address and password
  - Or silent connection with a key
- Earn Credit

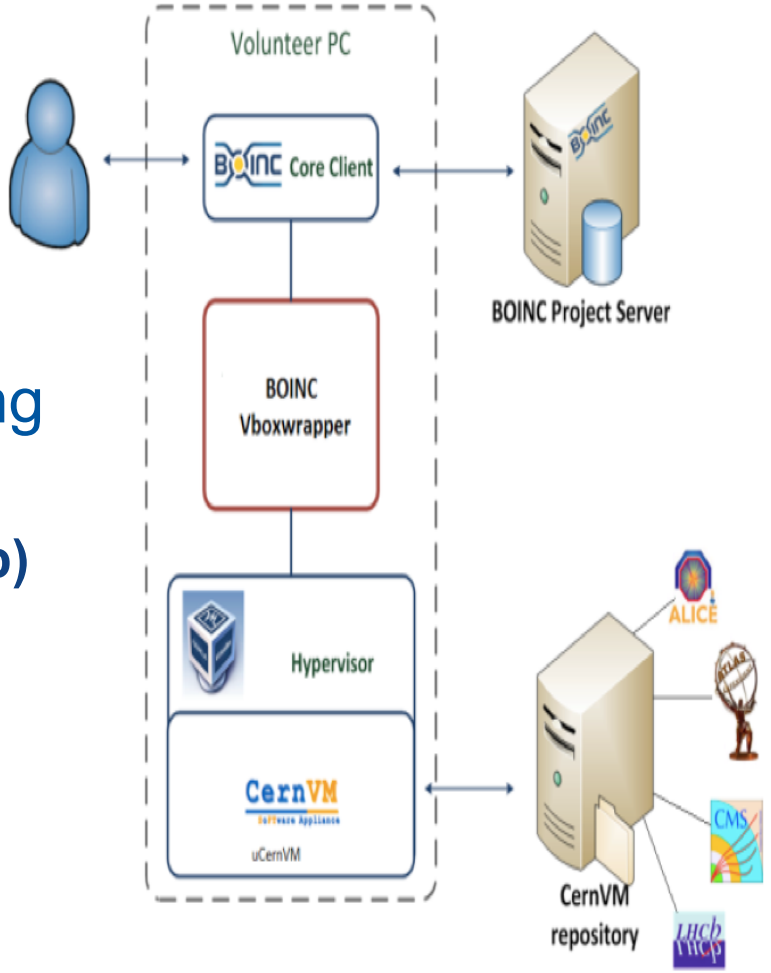


Challenges For HEP

- The cost of using the free resources (>100K hosts)
  - Initial integration requires investment
- Operations and maintenance
- Attracting and retention of volunteers
  - Advertisement
  - Engagement
- Low Level of Assurance
  - Anyone can register as a volunteer
    - Not the same level of trust as with Grid authentication

BOINC with Virtualization

- Pioneered with **Test4Theory** and **CernVM** 2010-2011
  - Included into the mainstream BOINC code
- BOINC projects currently deploying Virtualisation:
  - **CERN (Theory, ATLAS, CMS, LHCb)**
  - Climateprediction.net
  - ...
- Vboxwrapper: http://boinc.berkeley.edu/trac/wiki/VboxApps

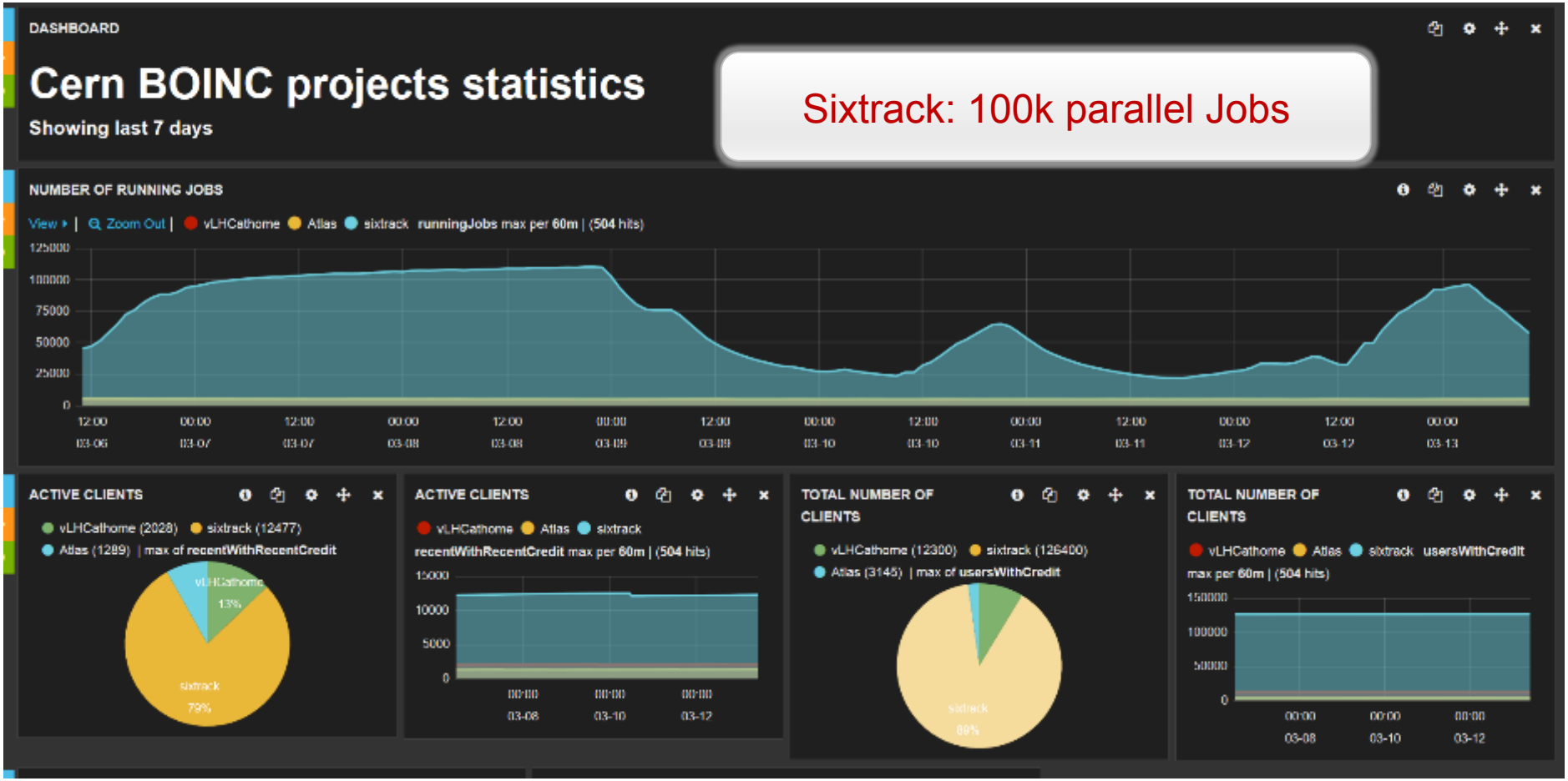


BOINC Service @CERN

- BOINC server cluster
  - LHC@home servers
    - Sixtrack, Theory, ATLAS
    - Test servers (CMS, LHCb, project with EPFL, Dev environments)
- BOINC server application support
  - MySQL database server back-end
  - BOINC server application configuration, updates and monitoring
- Handled by the project teams:
  - Porting of applications to BOINC
  - Application specific job management framework
  - Communication with users about scientific projects
  - Management of forums and portal content

CERN IT-PES

BOINC Service Monitor



CERN IT-PES: http://cern.ch/go/9nRz

SixTrack (LHC machine)

- Original classic BOINC project for beam simulations
  - Calculates stability of proton orbits in the LHC accelerator
- Based on experience from the Compact Physics Screensaver (CPSS)
  - Ran SixTrack on desktop computers at CERN
- Outreach project for CERN's 50th anniversary 2004
  - Also Year of Physics (Einstein Year) 2005
- Renewed effort for LHC upgrade studies (HL-LHC)
  - 12K Active Users
  - 19K Active Hosts
  - 35 TeraFLOPS

Test4Theory

- Theoretical fitting of all past experimental data
  - Including from the LHC
  - Using Monte Carlo simulation based on Standard Model
- Launched 2011
  - In partnership with the Citizen Cyberscience Centre (CCC)
- Pioneered use of Virtualization with BOINC
- Uses recent developments from CERN's PH-SFT Group
  - CernVM
  - CernVMFS
- Wide range of potential (physics) applications
  - In 2014 changed name to Virtual LHC@home
- Total of 1.7 trillion events simulated since 2011

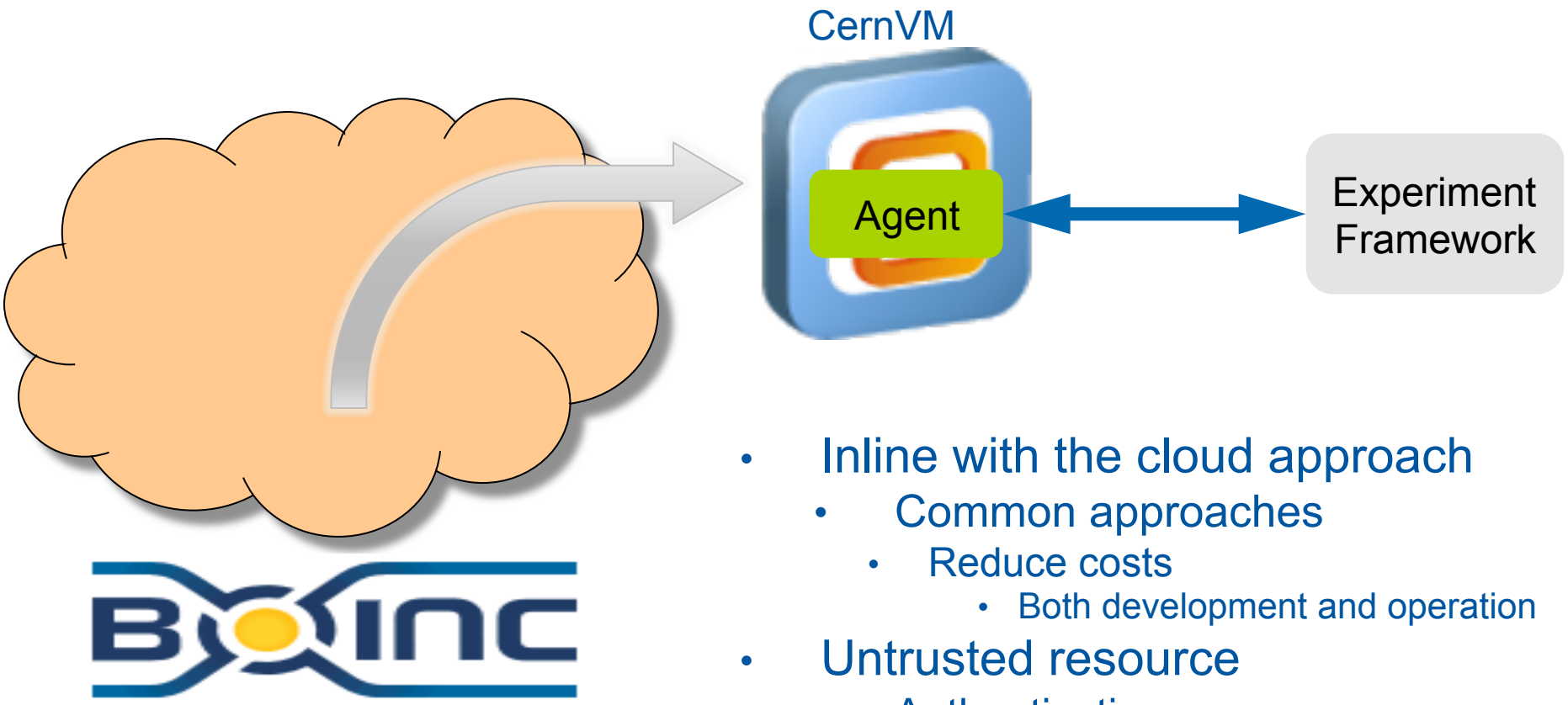
BOINC For LHC Experiments

- Use CernVM and virtualization
- Belong to LHC@Home project
  - Follow the **Vacuum model**
  - Beauty @home (LHCb)
    - In development since 2012
    - Communicates directly with DIRAC
  - ATLAS@home
    - Started as pilot beginning of 2014
    - ARC CE used to interface with BOINC
    - PanDA for job management
    - Supports simulations

CMS@home

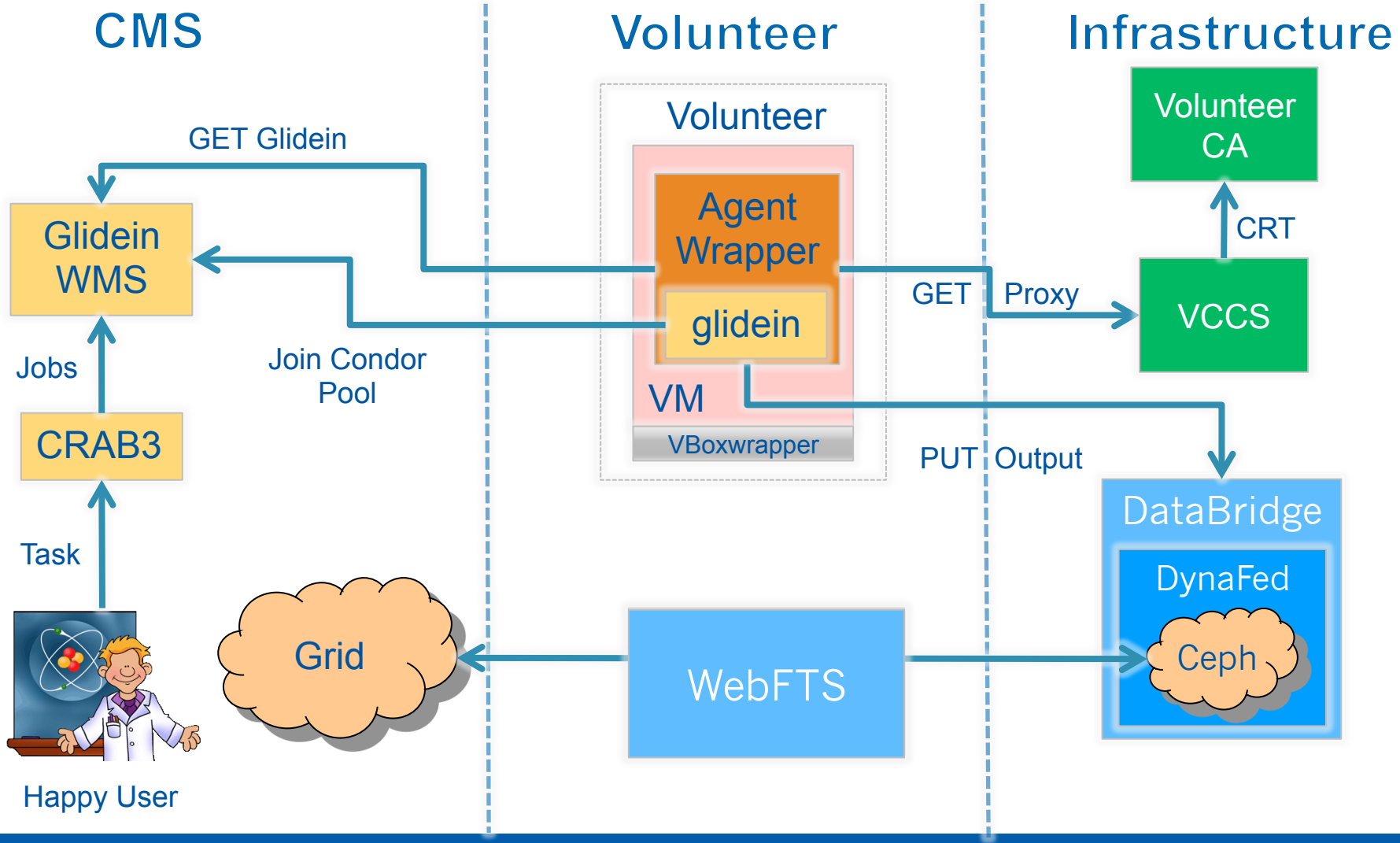
- Started development in Summer 2014
- The integration with Analysis framework (CRAB) is achieved
  - Available from the **production** Analysis infrastructure
  - Supports users' private MC generation
- The integration with Production framework (WMAgent) is on-going

The Vacuum Model

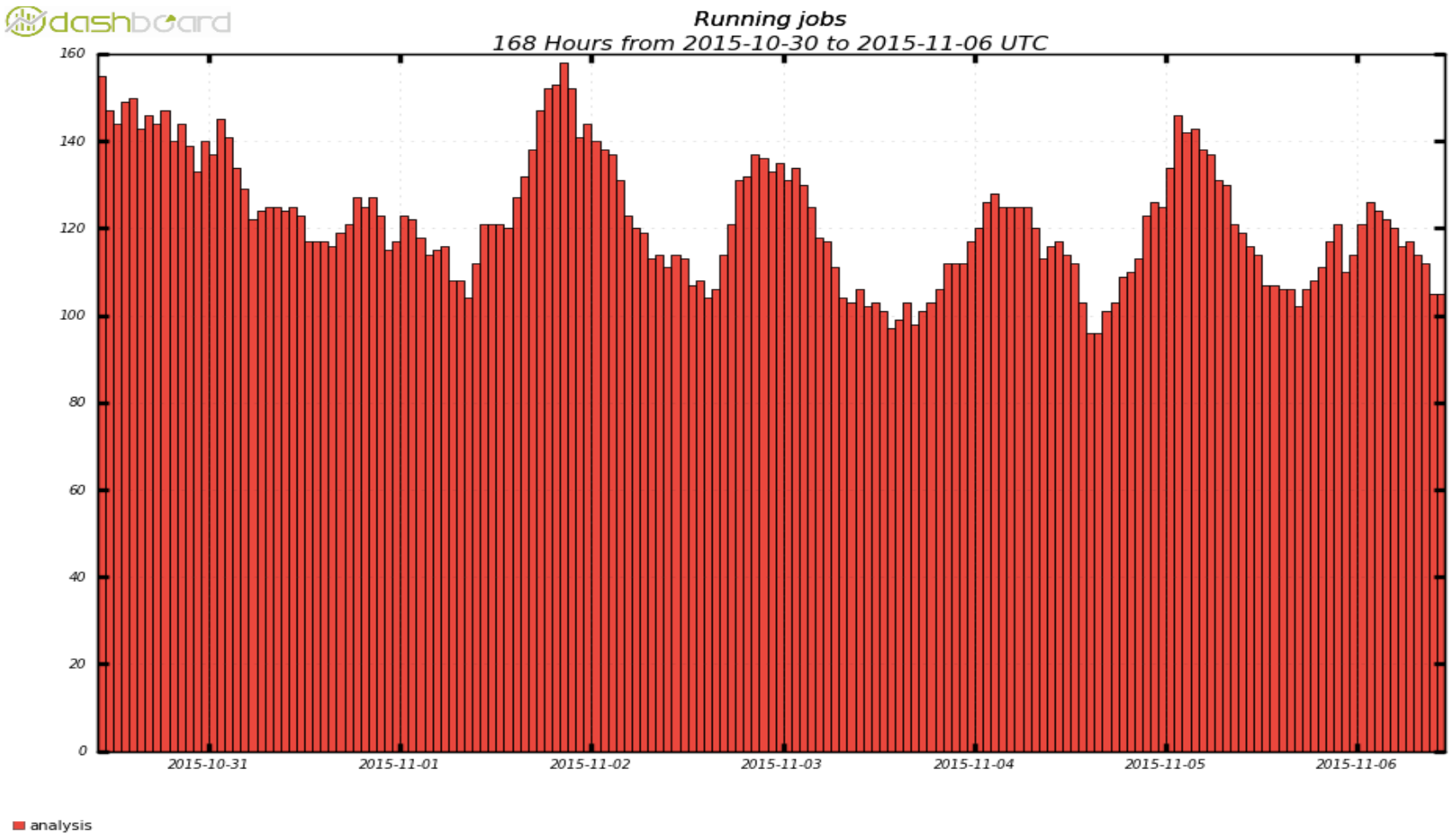


- Inline with the cloud approach
  - Common approaches
    - Reduce costs
      - Both development and operation
- Untrusted resource
  - Authentication
  - Validation

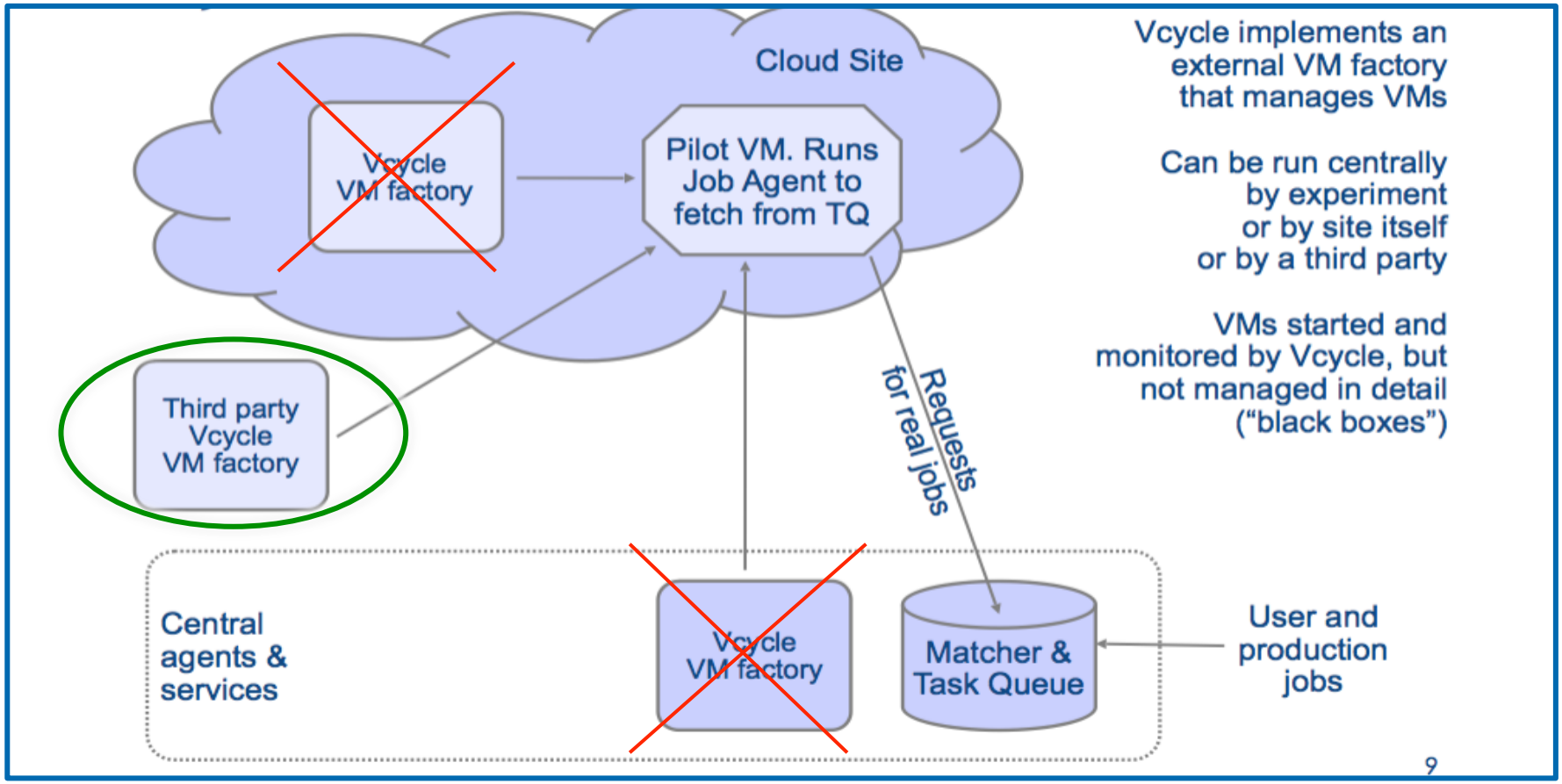
CMS@home architecture



CMS@home Usage

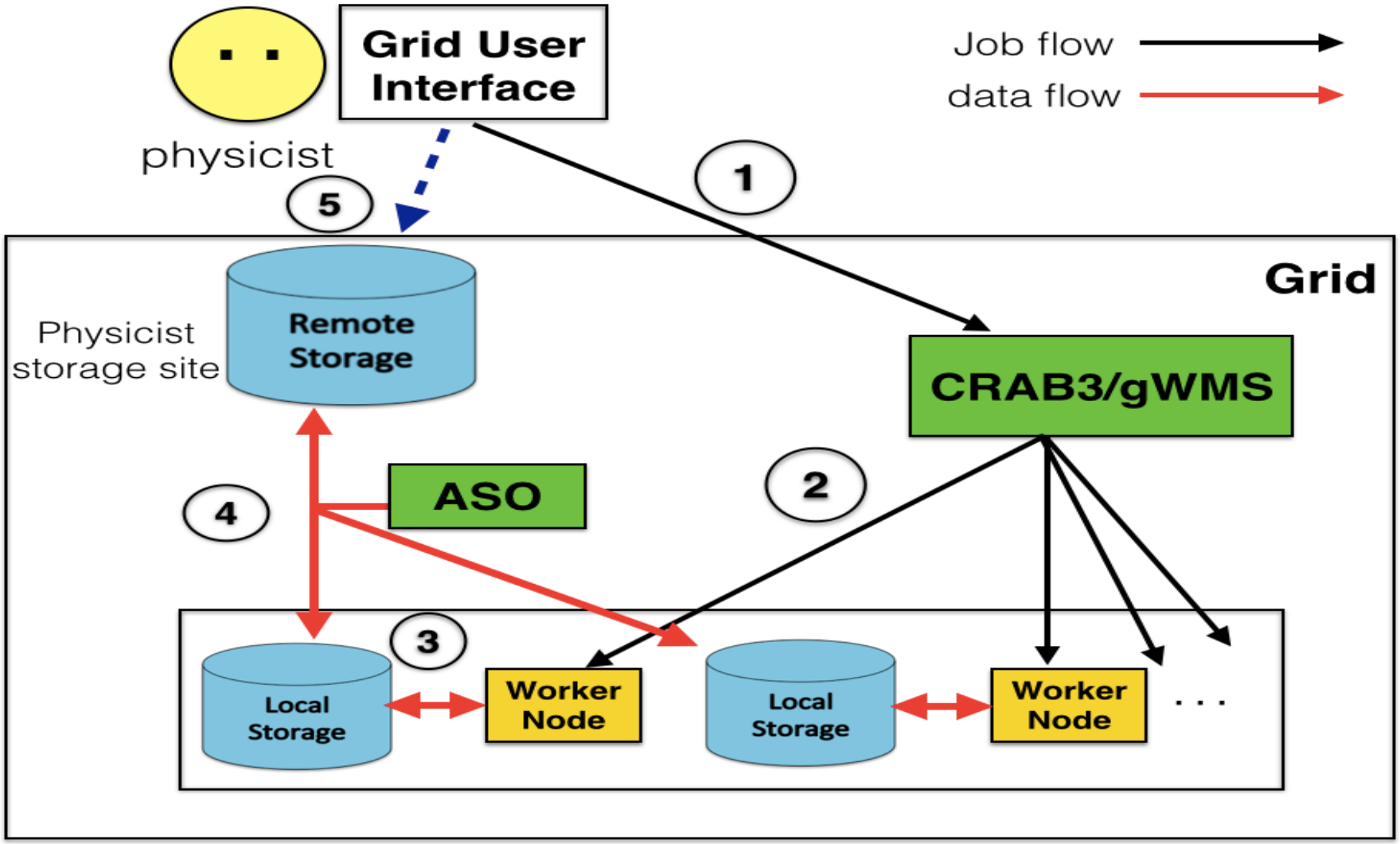


EGIFedCloud integration in WLCG



Andrew McNab *et al.* - HEPiX Spring 2015 - "The Vacuum Model for running jobs in VMs"

CMS Analysis workflow



Cloud accounting for WLCG

Laurence Field – GDB Nov. 2015 – "WLCG Resource Reporting"

Action List

- Analysis and proposal document ✓
- Publishers available [1] ✓
  - OpenStack ✓
  - OpenNebula ✓
- Normalization method ✓
  - Example provided [1] ✓
- WLCG view in the EGI Accounting Portal [1] ✓
- Extend REBUS to incorporate information from the portal ✗

- [1] https://twiki.cern.ch/twiki/bin/view/ITSDC/WLCGResourceReporting
- [2] http://accounting.egi.eu/cloud_tier2.php

- Only some WLCG sites joined the EGIFedCloud
  - Need to work with sites/VOs to deliver pledged resources

EGIFedCloud resources for CMS

- 4 CMS sites have joined so far
  - Pilot site: **INFN-PRISMA-BARI**
    - Great infrastructure support by Marica Antonacci (Thanks!)
- Only dozens of cores
  - Resources are mainly used for testing
  - Pilot infrastructure for the vacuum model in CMS
    - Used now for CERN Commercial Cloud/CMS@Home
- Consumer side accounting: cms-ganglia
- Daily log: DailyLogCMS
- CMS SAM tests: RAL-CMS-SAM

EGIFedCloud integration status for Analysis

- Vcycle instances at CERN ✔
  - It supports multiple providers (tenants) and VOs (contextualization)
- CRAB3 submission ✔
  - Submission to **CRABServer@prod**
  - Job type: Analysis/PrivateMC
- Registration in CMS information system ✗
- Job execution ✔
  - The job reads the input data, executed and stage-out the outputs
    - Data is read via XrootD and the stage-out is done directly or via ASO
- CMS Job Monitoring Dashboard reporting ✔

Results

Task: **151105_162406:riahi_crab_20151105_172400**

NJobTotal: **1000** Pending: **0** Running: **0** Unknown: **5** Cancelled: **0** Success: **995** Failed: **0** WNPostProc: **0** ToRetry: **0**

Data | Charts | Show 25 entries | *All times are in UTC | Search:

Id	Status	ExitCode	Site	Retries	Submit	Start	Finish	Wall Time	Logs	Input Files	FTS File Status
6	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05-11 16:54:20	05-11 17:00:31	00:06:11	Job,Post Job	File Info	N/A
7	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 16:56:27	05-11 17:04:22	00:07:55	Job,Post Job	File Info	N/A
8	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 16:41:49	05-11 16:47:49	00:06:00	Job,Post Job	File Info	N/A
9	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 17:01:54	05-11 17:05:48	00:03:54	Job,Post Job	File Info	N/A
10	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05-11 17:09:54	05-11 17:14:41	00:04:47	Job,Post Job	File Info	N/A
11	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 16:49:51	05-11 16:54:52	00:05:01	Job,Post Job	File Info	N/A
12	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 17:10:43	05-11 17:14:44	00:04:01	Job,Post Job	File Info	N/A
13	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05-11 16:29:47	05-11 16:35:02	00:05:15	Job,Post Job	File Info	N/A
14	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 16:36:24	05-11 16:43:27	00:07:03	Job,Post Job	File Info	N/A
15	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05-11 17:14:22	05-11 17:19:51	00:05:29	Job,Post Job	File Info	N/A
16	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 17:16:28	05-11 17:23:33	00:07:05	Job,Post Job	File Info	N/A
17	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 16:50:41	05-11 16:58:30	00:07:49	Job,Post Job	File Info	N/A
18	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:00	05-11 17:21:57	05-11 17:27:21	00:05:24	Job,Post Job	File Info	N/A
19	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05					
20	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05					
21	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	10					
22	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05					
23	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05					
24	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05					
25	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:02	05					
26	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05					
27	finished	0	T3_CH_EGIFedCloud	1	05-11 16:25:04	05					
28	finished	0	T3_CH_EGIFedCloud	1	05-11 16:24:42	05					

- Test of the execution of a privateMC workflow submitted with CRAB3
  - Generate minimum bias events with the Pythia MC generation
  - 1000 jobs (100evt/job)
  - Direct stage-out in a CMS Tier-2

Conclusions

- Volunteer Computing can and is providing
  - Significant additional computing resources
    - Potentially O(100K) machines
- The experiments are trying to exploit this opportunistic resource
  - Many @home projects exist or are in development
- The vacuum model has been adopted with success for exploiting both EGIFedCloud and volunteer clouds resources for LHC experiments
- Needs to attract WLCG cloud sites to integrate their private cloud in EGIFedCloud
  - Work with them to update their usage report to join WLCG production environment

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