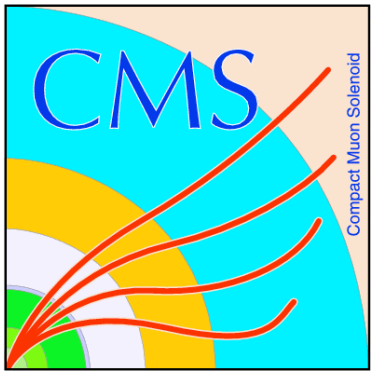

Elastic Computing from Grid sites to External Clouds

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Abstract

Scientific experiments nowadays require ever-**increasing computing resources**

- Often they work in a ***"burst"*** modality:
  - peak usage periods where resource usage greatly increases with respect to periods of "normal“ usage

Traditional scientific (non-commercial) computing centres (CC) may find it difficult to size themselves

- They cannot be sized for peak usage
- They cannot acquire extra resources on demand
- Finally, they cannot absorb the peak usage of the experiments without generating excessively long queues.

Dynamic resources provisioning:

Access Cloud resources provided by external partners or commercial providers

- INFN- along the lines followed by other WLCG sites – is exploring the opportunity to access Cloud resources in order to cope with the request peaks

Bologna Tier3 Proof of Concepts

Dynamic resources provisioning

- Cloud Bursting: extending an existing site's LAN based batch system to:
  - Bologna Tier3 inside CNAF Tier 1 domain
  - Bologna Tier3 outside Tier 1 environment: Openstack

Access a newly defined Cloud-based WLCG site through experiments Workload Management Tools

- CNAF Openstack and CMS Production Workload Management Infrastructure

Cloud Bursting:
extending existing site's queues

Cloud Bursting from an LSF site

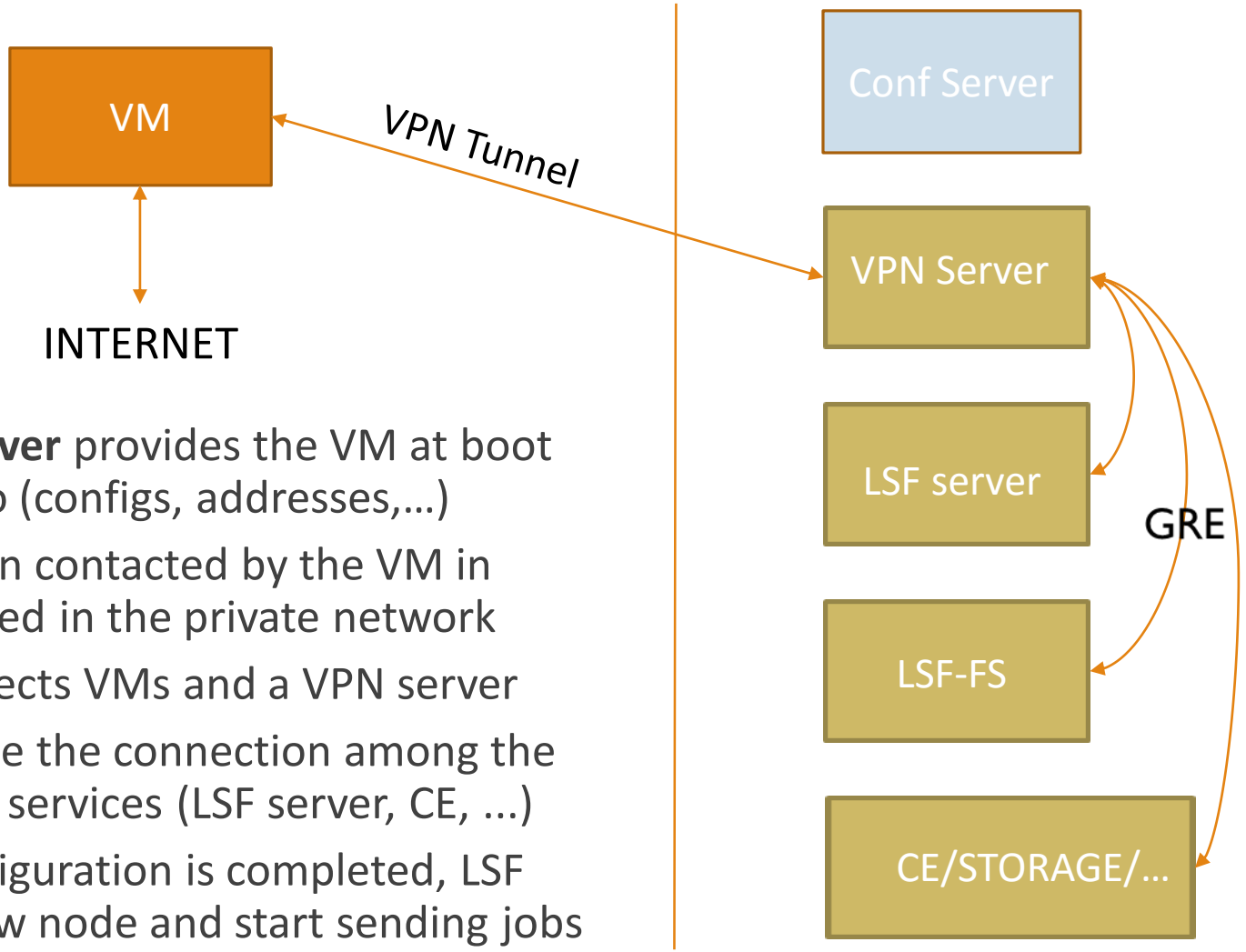
The idea: enabling dynamic extension of batch system working inside a LAN (e.g. LSF)

Problem: LSF does not support dynamic extensions of the batch queues

Solution: a VPN where new nodes (VMs) can be added dynamically

- No requests on the hypervisor
  - VMs can be run everywhere, Cloud providers included
- Only request on the VM is the installation of 2 additional rpms
- The network traffic is reduced to the minimum

The VPN configuration



- A **configuration server** provides the VM at boot with all needed info (configs, addresses,…)
- A **VPN server** is then contacted by the VM in order to be registered in the private network
- A **VPN tunnel** connects VMs and a VPN server
- A **GRE tunnel** enable the connection among the VMs and necessary services (LSF server, CE, ...)
- As soon as the configuration is completed, LSF Master sees the new node and start sending jobs

Dynamic Extension of the Bologna Local Farm

Step 0: *Virtualization*

- Used custom, «lightweight» images
  - Relying where possible on remote service (CVMFS)
  - No EMI Grid Software
- Where possible, reused existing Tier3 configurations
- Tested access to Tier-3 GPFS storage

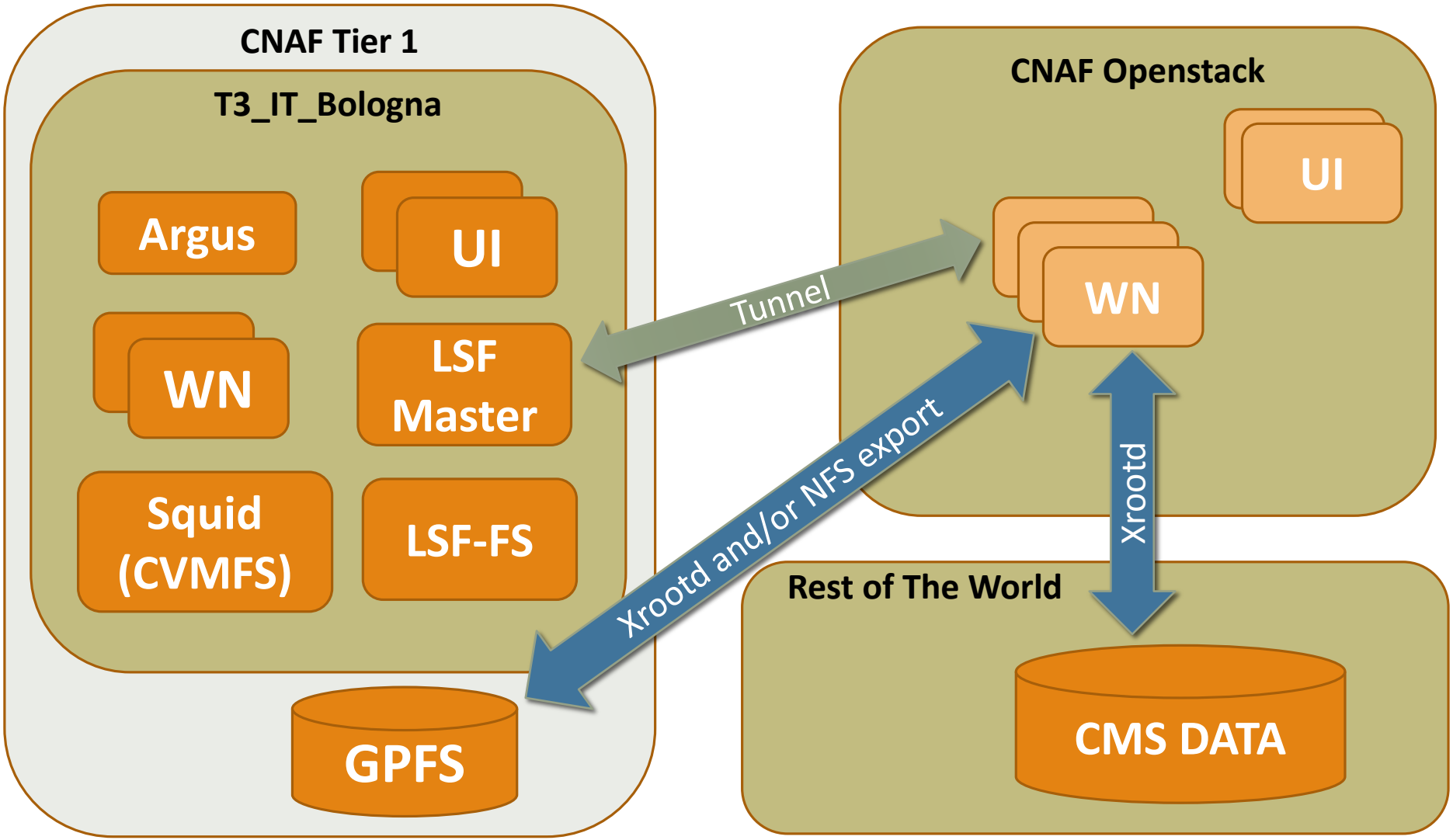
Step 1: *extending Bologna Local Farm*

- E.g.: adding static nodes to the farm and accessing them through a test LSF queue
- Testing the LSF dynamic extension

Step 2: *extending Tier3 Grid site to CNAF Openstack*

- E.g.: plug VM instantiated on Openstack into a Grid production queue

The Extended Tier3 configuration



Bologna Tier3 Cloud Bursting

Successfully performed the Bologna Tier-3 extension

- Tested over the CNAF Openstack infrastructure (both Havana and Juno)
- Experimented the access to the local storage (gpfs) through nfs export
  - Not ideal solution: bottleneck for the VMs and the whole gpfs system
  - Switched back to remote data access (xrootd, srm)

New nodes seen as “normal” Tier-3 nodes from Grid submission

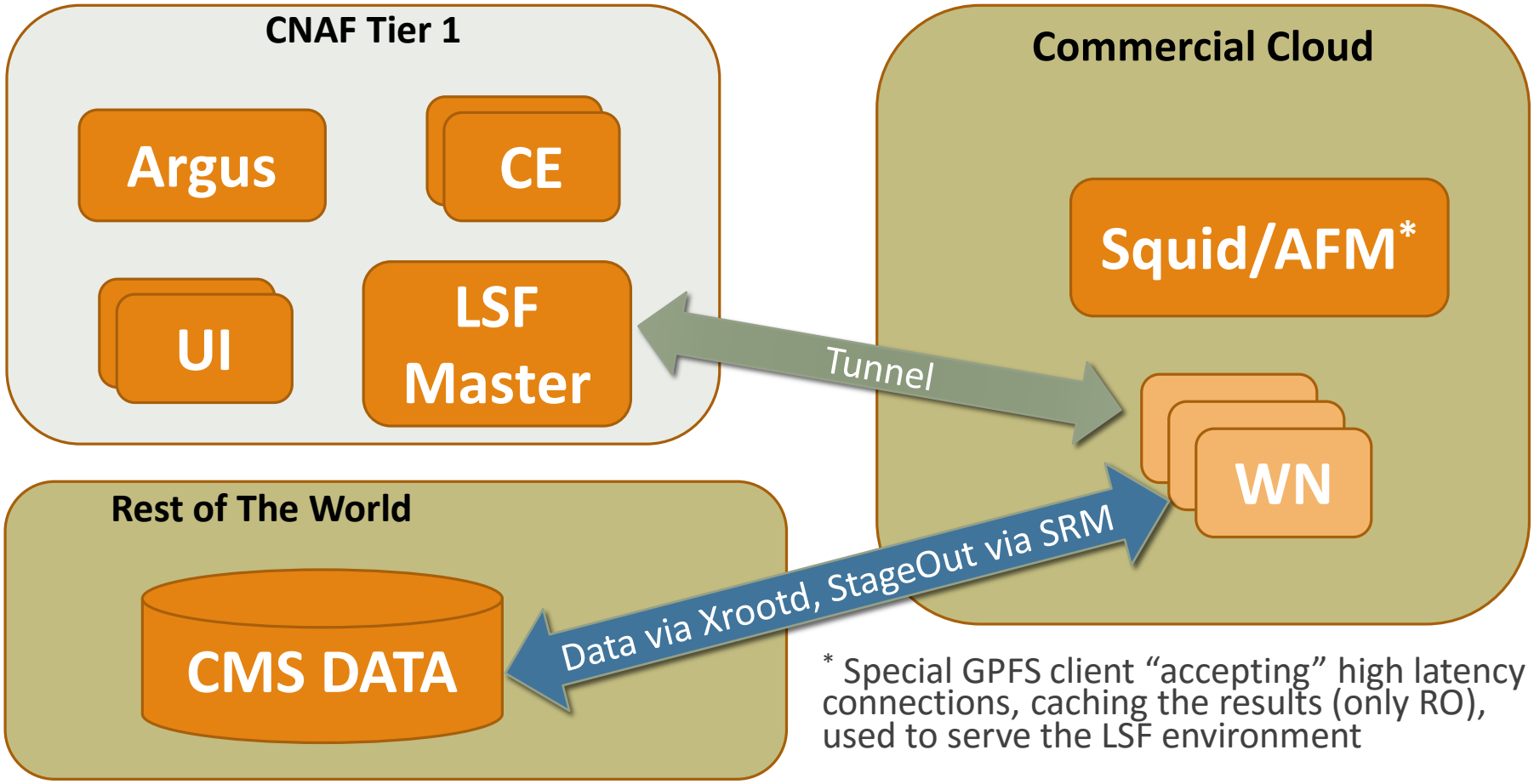
Completely transparent for the CMS tools:

- **used in the production system!**

Submitted >3000 jobs

- Using standard CMS workflow for final Analysis Objects creation
- Jobs spread among physical nodes and plugged VMs
  - About 5% reached the virtual nodes
- No failure observed

Extending over commercial resources: an example



* Special GPFS client "accepting" high latency connections, caching the results (only RO), used to serve the LSF environment

For the ***real application***, see "*Elastic CNAF DataCenter extension via opportunistic resources*" presented by Dr. Stefano DAL PRA on 18 Mar 2016 at 10:00

The Bologna Tier 3 as a Pure Cloud Site

A CMS Site «as a Service»

Using the Bologna Tier3 setup we created a brand new, decoupled CMS site «as a service» in Openstack

- Registered as T3_IT_BolognaCloud inside CMS WM system

Access the new Site through the standard CMS WM tools

- CRAB: analysis jobs submission tool
- GlideIn-WMS: job management tool
- (WMAgent: production jobs submission tool)

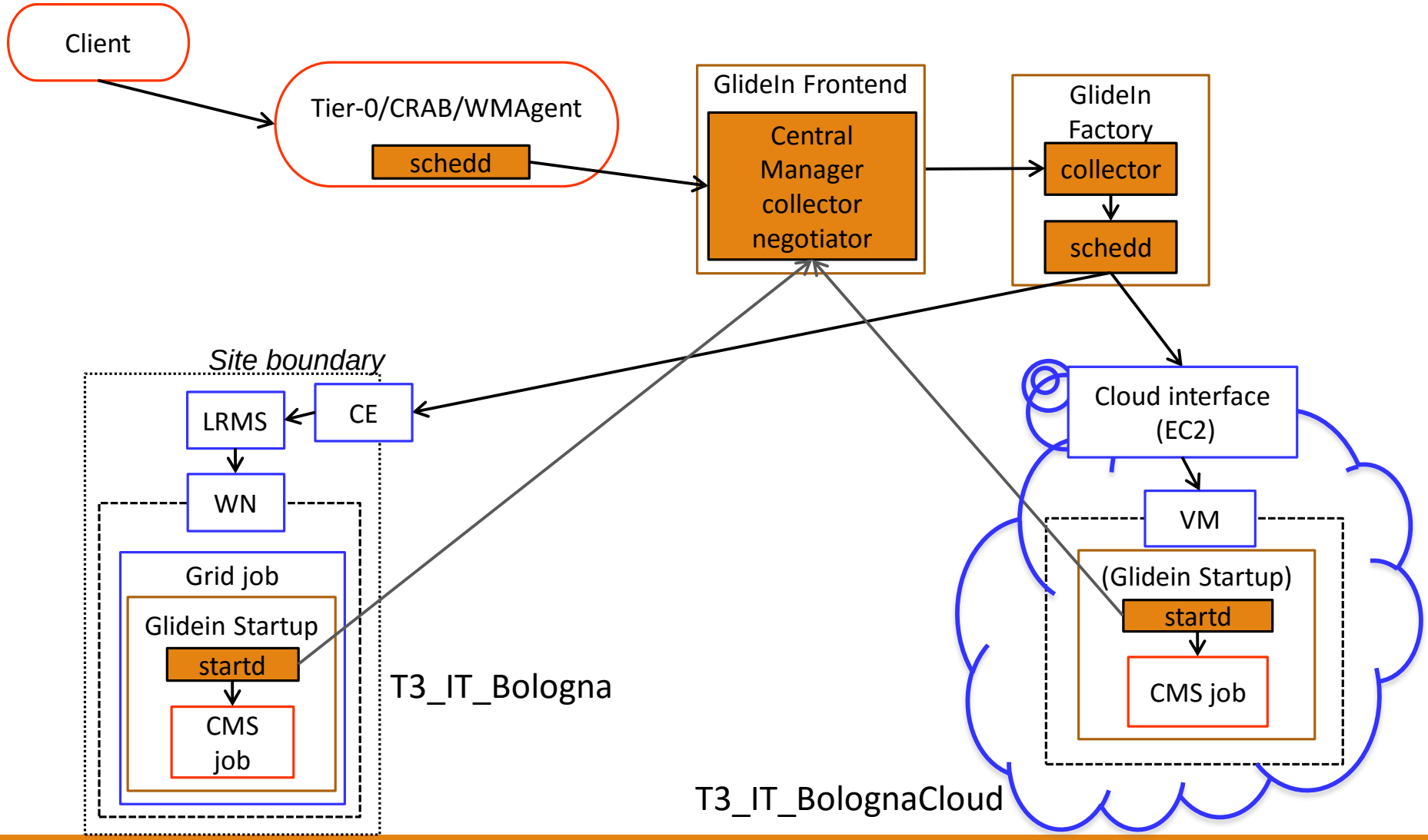
The first step:

- Re-exercising the CRAB v2 + Custom GlideIn-WMS + Openstack Havana chain
  - CRAB v2 is a pure command line tool, in our case tuned to work with custom GlideIn-WMS

The new CMS wide test:

- Using CRAB v3 + CERN Integration Test Bed (ITB) GlideIn-WMS + Openstack Juno
  - CRAB3 is a client-server infrastructure: needed to use production tools!
  - ITB GlideIn-WMS is a central infrastructure for pre-production tests
  - This exercise was one of the first main test for the newly Openstack Juno CNAF installation

Tier3 as a Service at CNAF Openstack



CNAF Openstack as a CMS site

We used Bologna Tier3 setup in order to create a new site “as a service”

- Custom, “lightweight” images
- No need to create a new site
  - Only GlideIn-WMS need to be aware: high flexibility in instantiating sites on-demand

Successfully used crab3 + ITB GlideIn-WMS+ Openstack Juno

- Using standard CMS workflow for final Analysis Objects creation
  - VM flavor: Quadcore, 8GB RAM VMs
- Also tested more memory+CPU intensive tasks (reconstruction jobs for upgrade scenario)
  - VM flavor: Quadcore, 12GB RAM VMs
- Submitted 4 task made of 200 jobs each
  - Using a production infrastructure, our resource slot was limited
- No failures observed
- Good job efficiency (peak at about 98%)
  - Efficiency = (CPU Time)/(Wall Clock time)

Next Steps and Plans for the Future

We used custom lightweight images reproducing Bologna Tier-3 existing configuration

- Next step could profit of the µCernVM images
  - Generic ISO image 12 MB sized with OS entirely on CVMFS
  - Faster to instantiate, easier to keep up-to-date
- Already used by other LHC experiments and recently adapted also by CMS

We tested the dynamic extension for the CMS only case

- Bologna Tier3 is a multi-VO environment
- We are working to extend the usability to ATLAS

Using µCERNVM + Parrot under Docker, the requests on the host system can be further reduced:

- No kernel privileged access

The Bologna Tier3 is a local users facility

- It can be costly in terms of maintenance and manpower
- We can profit of the exercise to turn the Site into a purely Cloud site if the others customer VO's are able to adapt
- We can opportunistically expand over non-used CNAF Tier1 resources

Summary

Using Bologna Tier3 setup we realized two prototypes for the extension of a Grid site into Cloud resources

- We tested the dynamic extension of a CMS site over external resources with production tools
  - Bologna Tier3 over CNAF Openstack
- We tested the access of a purely Cloud instantiated CMS Site with production tools

The proof of concept realized are already serving bigger scale projects

- Extending the CNAF Tier1 over commercial resources (ARUBA, Italian Cloud provider)
  - see "*Elastic CNAF DataCenter extension via opportunistic resources*" presented by Dr. Stefano DAL PRA on 18 Mar 2016 at 10:00
- Looking forward the opportunity to define the Tier3 as a pure Cloud instanciated site inside the CNAF Tier1 Openstack infrastructure to reduce mantainance costs

Credits

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