A DevOps Approach to Integration of Software Components in an EU Research Project

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Software as Research

An article about computational science in a scientific publication is not the science itself, it is merely advertising of the scholarship. The actual scholarship is in the complete software development environment, [the complete data] and the complete set of instructions which generated the figures. — David Donoho "Wavelab and Reproducible Research", 1995

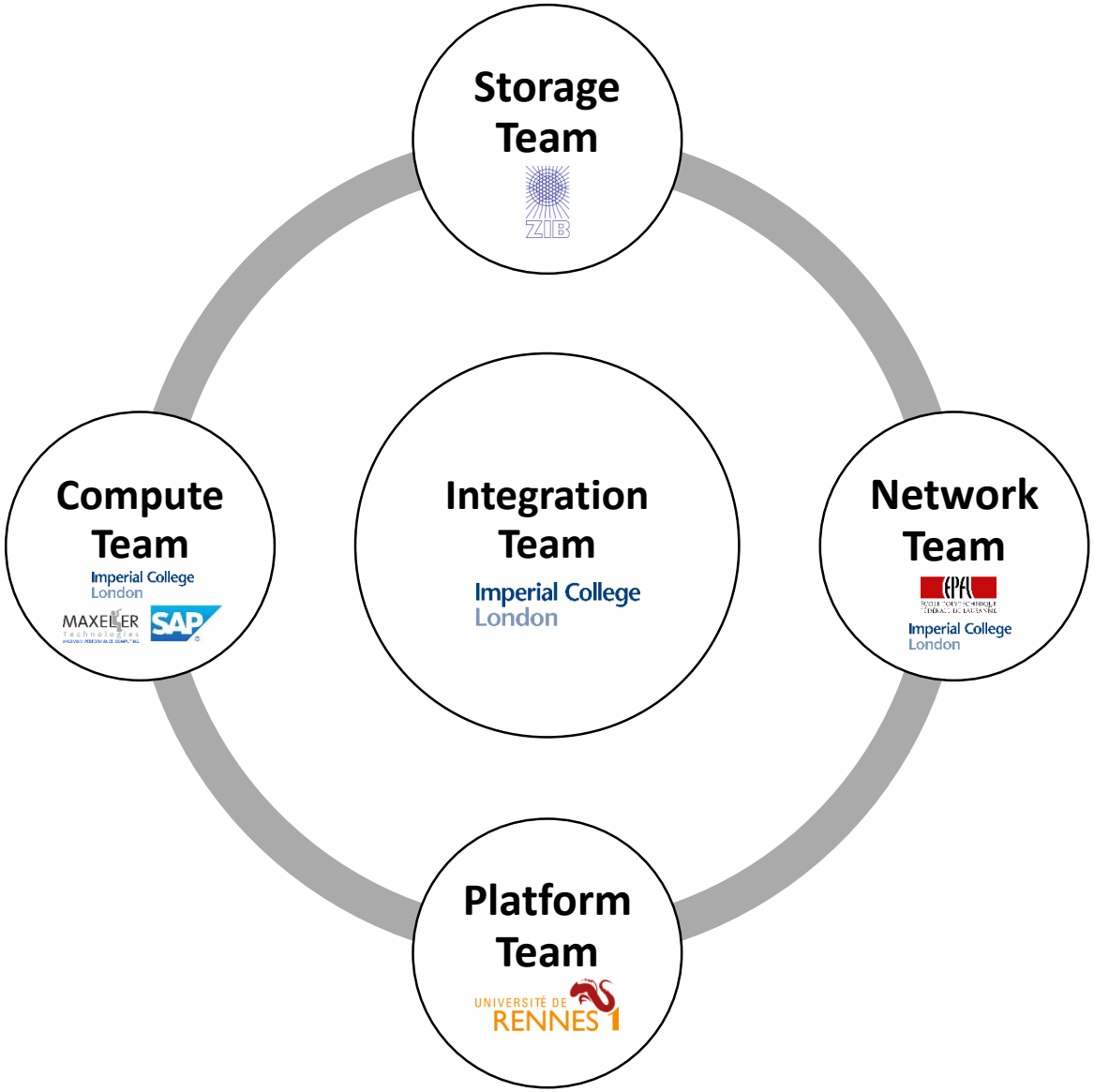
Funder Expectations

- multi-partner collaborations
- results data and code as research outputs
- reusable and maintainable software
- plans for long-term stewardship

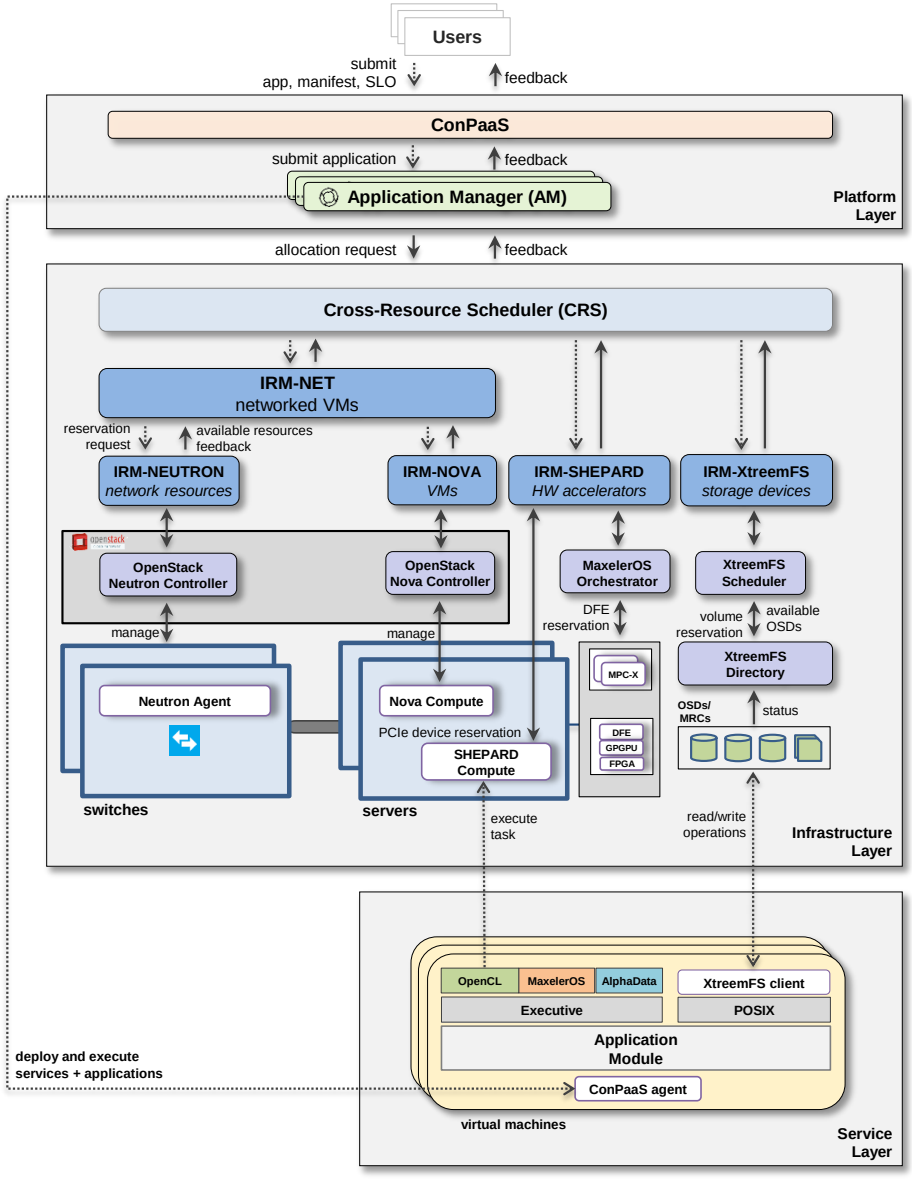
HARNESS Project Summary

- EU FP7 funded cloud computing project
- makes available various heterogeneous resources
- multiple sub-projects developed by independent teams
- need to provide coherent demonstrator platform

HARNESS Project Teams



HARNESS Project Architecture



Testbed Environments

- Imperial Testbed
  - small scale
  - static environment with shared systems
  - specialized hardware (GPU, MPC-X, SSD cards)
- Grid5000 Testbed
  - medium to large scale, some multi-site deployments
  - dynamic environment
  - virtual networking links
  - some specialized hardware (GPU, Intel Phi)

Initial Approach

- developer virtual machine images
- interactive configuration with some scripting (bash, devstack)
- scheduled releases of updated images

Significant Issues

- difficulty merging, managing, and tracking changes
- individual developer VMs tend to "drift" over time...
- fragmentation: hard to point to a definitive latest version
- difficult to debug or identify differences between images
- time-consuming and error-prone deployment to testbeds

Objectives for New Approach

- let developers easily work individually
- turn configuration/setup issues into software issues
- allow for version control, merging
- allow for automated acceptance testing

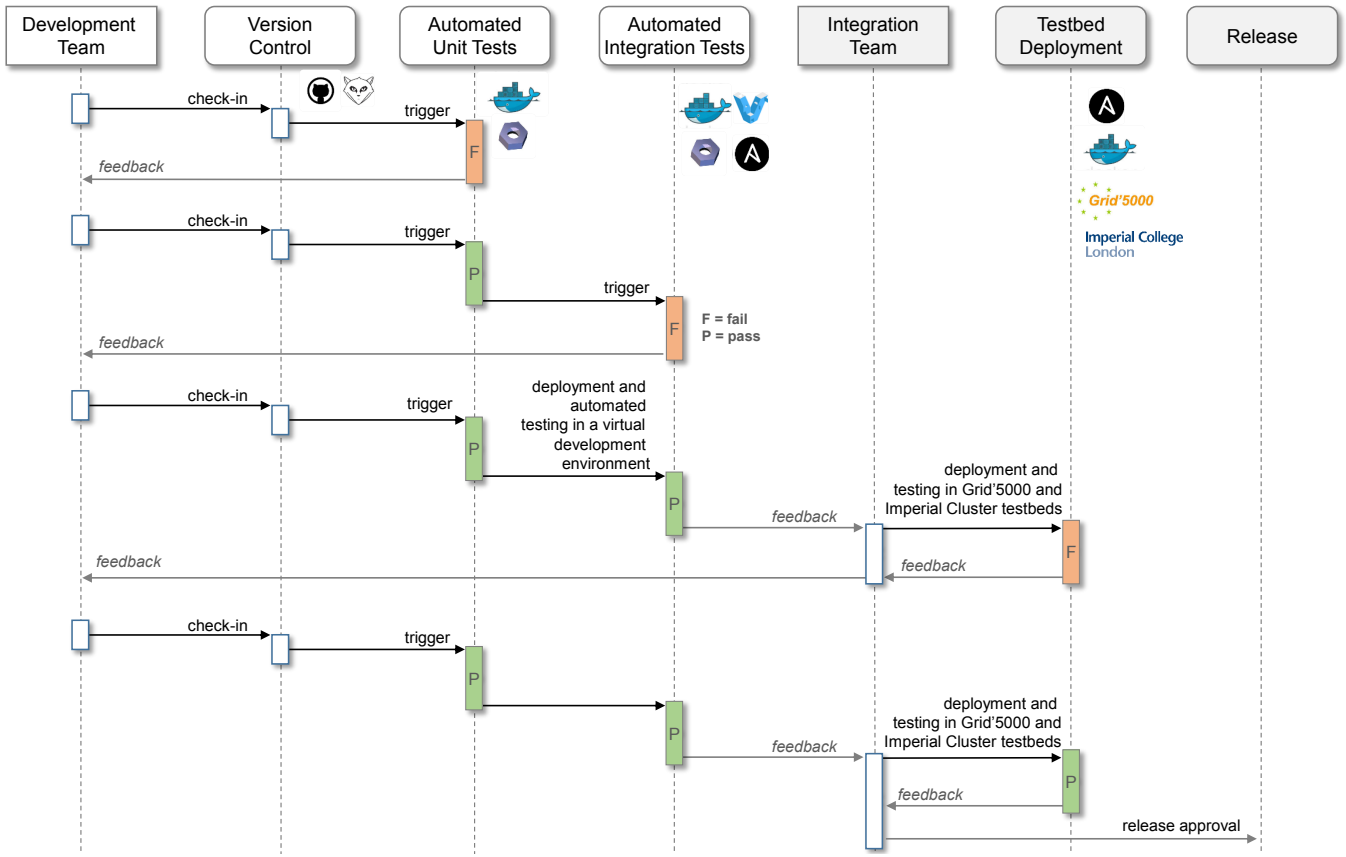
Differences from Commercial Requirements

- priority is individual research contributions
- lower focus on ease-of-use
- more need for customization
- need for reproducibility

Technologies

- Git / GitLab / GitHub
- Ansible
- Docker
- Vagrant
- Buildbot

DevOps Workflow



Role of Docker

- Docker used whenever possible
  - some services need global machine state
- provides static release images, with some configuration
- isolates projects from each other

Deployment Projects

- use ansible for orchestration and configuration management
- unify sub-projects, pull in from multiple repositories
- ansible ensures configuration changes are “idempotent”, so can be run repeatedly on static testbed

Virtual Machine Environments

- configured using vagrant+ansible
  - developer just checks out deployment, runs “vagrant up”
- allows developers to work independently
- easy to re-initialize or update

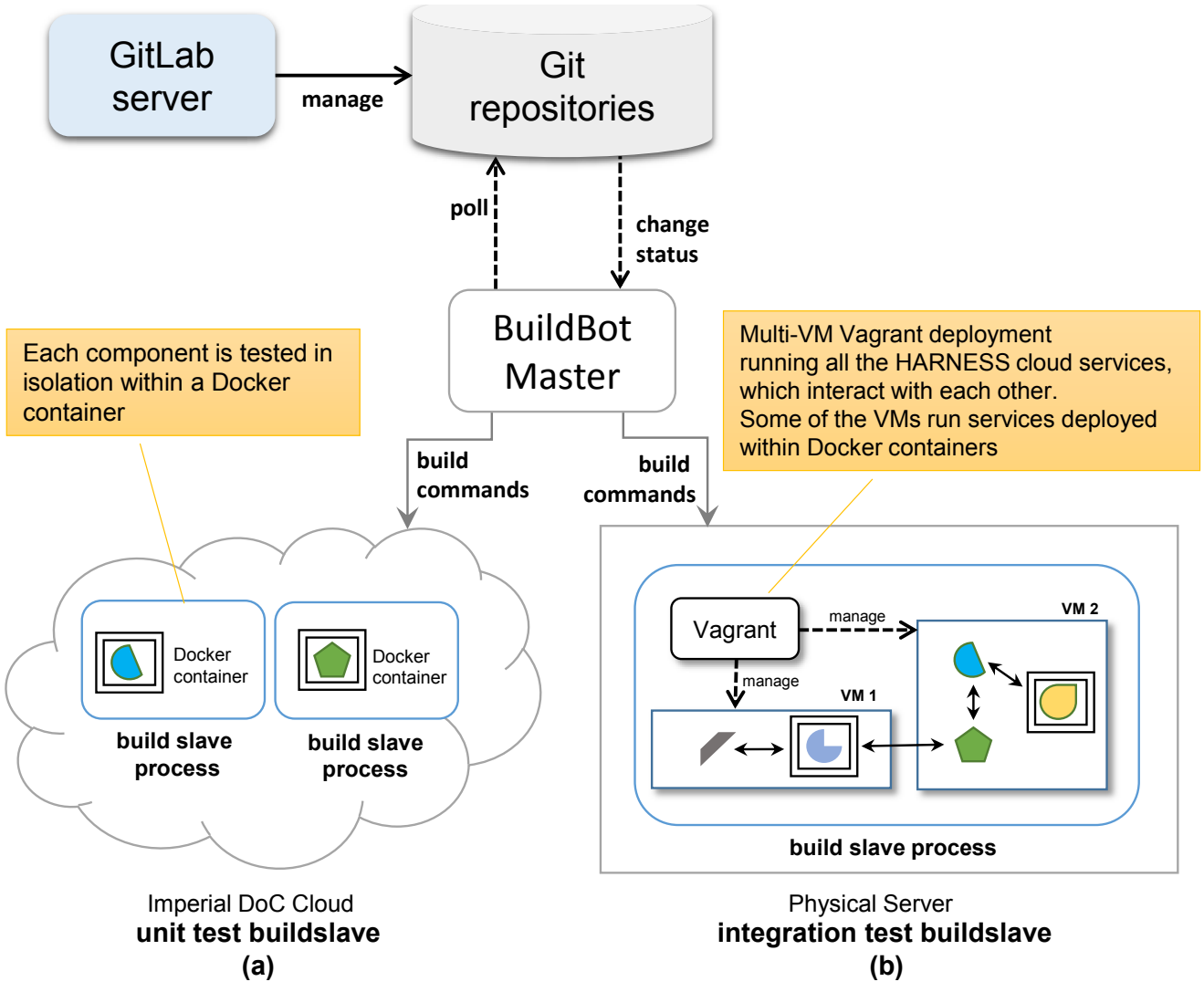
Reproducible Deployment

- developers work in the same environment, changes easily merged
- experiments and benchmarks can be validated at a later date
- software can be deployed on novel testbeds
- rapid recovery in case of hardware failure

Automated Testing

- unit tests for individual projects
- integration test for full deployment

Buildbot


GitLab server
manage
Git repositories
poll
change status
BuildBot Master
Each component is tested in isolation within a Docker container
Multi-VM Vagrant deployment running all the HARNESS cloud services, which interact with each other.
Some of the VMs run services deployed within Docker containers
build commands
build commands
Docker container
Docker container
build slave process
build slave process
Vagrant
manage
manage
VM 1
VM 2
build slave process
Imperial DoC Cloud
unit test buildslave
(a)
Physical Server
integration test buildslave
(b)

Shortcomings

- difficult for non-experts to make configuration changes
- difficult to manage temporary branch changes for developers
- considerable development burden shifted to integration team
- running the full virtual deployment in vagrant on server takes a long time

Lessons Learned

- ability to refresh developer vms *extremely* useful
- automated deployment also very useful, but requires expert supervision
- testing results often ignored

Future Recommendations

- gatekeeper for authoritative versions
  - do not publish/merge changes until tests are passed!
- look into other techniques for projects with multiple repositories
- run integration tests against cloud back end

Discussion Points

request for feedback/discussion about a particular point in our work:

How can we better manage projects that pull from multiple repositories?

thought-provoking statement or discussion question about the area:

What are appropriate metrics of success for this type of project?