CERN IT Systems Management

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Outline

- General strategy
- Puppet for configuration
- Automation
- Data-centre and service monitoring
- Data-centre capacity plans
- Cloud and containers
LHC compute scaling challenges

The outline LHC schedule out to 2035 presented by Frederick Bordry to the SPC and FC June 2015 can be found [here](#).

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### WLCG CPU Growth

- Tier2
- Tier1
- CERN

**20% Growth**

**Current state**

**2008-12 linear**

Compute: Growth > x50

What we think is affordable unless we do something differently.

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13 April 2016

2nd Workshop on DAQ
Good News, Bad News

• Additional data centre in Budapest now online
• Increasing use of new facility as data rates increase

But…
• Materials budget decreasing, no more money
• Staff numbers are fixed, no more people
• Legacy tools are high maintenance and brittle
• User expectations are for fast, dynamic self-service
General strategy

- As we scaled-up and made things more dynamic, our home-baked tools started to break and we struggled to find the effort to fix them

- **How can we avoid the sustainability trap?**
  - Really try hard to not develop our own stuff
  - Avoid accumulating technical debt
  - The major driver for the Agile Infrastructure was to control the technical debt

- **How can we learn from others and share?**
  - Find compatible open source communities
  - Contribute back where there is missing functionality
  - Stay mainstream

Are CERN computing needs really special?
O’Reilly Consideration

Managing Infrastructure with Puppet

OpenStack Operations Guide
CERN Tool Chain

- puppet labs
- elasticsearch
- git
- openstack
- Ceph
- CentOS
- Hadoop
- RDO
- Kibana
- Foreman
- Rundeck
- Jenkins
Puppet for configuration

- Puppet roll-out has worked well for us
  - ~300 service manager with ~200 distinct hostgroups, both IT and experiment services
- Positive user experience
- Excellent open community support
  - Lots of standard modules
  - We’ve complemented this with a library of standard CERN configurations
- Solid APIs hooks for automation
Why Puppet?

• Several other obvious alternatives (Ansible, Chef, cfEngine,…)

• Puppet’s declarative language model fitted our users’ expectations (similar to previous tool)
• Centralised service model works well in our environment

• Solid community and good upstream support
  • This is the most critical aspect for anything you might chose

• We’ve invested in Puppet and we’re still very happy
  • We’ve no plans to move to anything else anytime soon :)
Configuration service plans

- Faster versions of Puppet in the pipeline
- Potentially replace some of our own stuff (e.g. secrets management) with products that community have subsequently released
- Focus now on automation
Ops automated testing

- Focus is now on automation to control ops cost as we expand capacity

- “Continuous Deployment” combining gitlab-ci, puppet, Openstack orchestration
   - Aim is to automatically test as much as possible before rolling out a change to production
   - Working on making it easy to do this for all service changes with easy-to-add validation tests for automated “qa” testing
Ops automation tools

• Lots on the open and open++ market
  • Stackstorm, Cloudify, Saltstack, Rundeck, ...
  • Several teams in IT using Rundeck just now

• Aiming at event-based automated recovery

• “Monitoring has not heard from this service for a while / has seen high-load”
  • → kick off a canned investigation / fix job
  • Everything in our infrastructure is now an API

• Rule #42: Only raise to a human when you run out of things to try
Infrastructure monitoring

- ‘Lemon monitoring service” backend now replaced by standard, open technologies
- Node metrics collected by Flume
  - Funneled to ElasticSearch for dashboards, Spark for online analysis and Hadoop for subsequent analytics
- Node exceptions (i.e. metrics out of bound) transported by ActiveMQ messaging
  - Can be subscribed to for automation events
  - Main “subscriber” is our ServiceNOW
New infrastructure monitoring (meter.cern.ch, based on Kibana/ES)
Infrastructure Monitoring futures

- Investigating further dashboard technologies and backend data stores
  - Currently ElasticSearch and Kibana
  - InfluxDB as possible backend
  - Graphana as possible dashboard

- Lemon agent replacement -> collectd?
  - Lower maintenance: replace all standard metrics
  - Make it cheap to create new metrics
  - Translation layer for residual Lemon sensors
Service monitoring

- ETF framework (from the WLCG SAM) based around checkMK and Nagios
  - Huge library of service check available
  - Currently used for monitoring services across the WLCG for availability reporting

- Extending soon to local service monitoring
  - i.e. is a service doing what it’s supposed to be doing
  - Useful directly for service managers
    - e.g. service dashboards
    - …but also an automated service recovery trigger
Streaming and analytics

- Lemon metric / exception / ETF streams can be monitored in real-time by Spark / Kafka or Esper
  - Register jobs hunting in real-time for more complex patterns ... firing a trigger
  - Event based automation
- Hadoop analytics
  - All data poured into Hadoop
  - Longer term problem investigation using analytics
    - e.g. understanding inefficiencies in the batch system
Physical DC Infrastructure

- **CERN Main Data Centre**
  - 3.8 MW for computing of which ~2.3 MW currently used
- **Remote hosting site (Wigner Data Centre in Budapest)**
  - 2.7 MW for computing of which ~1 MW currently used
    - Due to low rack power density, majority of available rack space currently used
  - Contract until end of 2019 but could be extended by 1-2 years (if necessary)
Options for additional capacity

• No firm plans yet.
• No plan to upgrade the Meyrin Data Centre further as it is considered that it would not be cost effective

• Investigating commercial clouds or external hosting as an option for providing additional capacity

• There is the option to do another tender for a remote hosting facility such as Wigner either as a sole solution or in combination with commercial cloud resources

• A final option, although not yet investigated in any way yet, would be a modular Data Centre addition, similar to the approach foreseen for LHCb and ALICE for post LS2 needs
How to integrate external capacity?

• Critical for ops cost to manage any external resources with same tools as we do here
  • Puppet / common monitoring
  • Possible restricted use-cases
  • Being tested now on IBM Softlayer / TSystems
  • Further procurements planned (HNSciCloud)

• Aim to expose (compute) resources only via common HTCondor lxbatch interface
  • one place to submit to for any CERN compute work
Private cloud

- Happy with Openstack
- **Cloud model has allowed us to scale within fixed manpower**
  - Emulate legacy environment – most services moved to VMs
  - Enable new ways of working
  - But difficult to avoid divergence / segmentation in fixed DC
- **Collaborations with open source and industry covers technical debt**
  - Future maintenance and testing
  - External mentoring avoids special solutions
  - Enhance staff job opportunities
Private cloud plans

• Keep running the cloud
  • New releases every 6 months
  • Around 2,000 servers / year to renew
  • Integrate bare-metal management with Openstack

• Change the cloud – variety of new things in the pipeline
  • Containers
  • Software Defined Networking
  • Fine grained accounting and quota
Container technology

• Potentially, a very lightweight way to deploy services
  • Focus on application code and scaling behaviour rather than deployment

• Various use cases: R as a Service, Jupyter notebooks for HEP analysis, pre-packaged batch jobs
• We’re testing Magnum from Openstack
  • Will deploy and scale for you a Docker Swarm, Kubernetes or Mesos instance

• Technology evolving very quickly in this space
• Aim to track and offer stable service
• CERN ITTF: https://indico.cern.ch/event/506245/
Summary

• We’ll keep doing configuration with Puppet
• Now focusing on the change testing and recovery automation
• Monitoring based on standard technologies; understanding which tools are best
  • Looking how best to integrate the monitoring with our automation efforts
• Various options for extending compute capacity
  • Validating providers, tools and experiment payloads in various providers now
  • No firm decisions yet
• Private cloud with Openstack – very happy with it
  • Manpower scaling well
Summary

• Moving to a set of solid, open-source based community products has helped us a lot

• New technologies, as they come along, are typically integrated quickly
  • Though you have to invest manpower to keep things up to date
  • Plus side -> any development effort you do (should be) integrated upstream

• We’re happy with the Puppet / Openstack stack ecosystem and would recommend it

• We believe we have a solid base which will serve us for a long time yet