Evolution of Cloud Computing in ATLAS

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on behalf of the ATLAS collaboration
The Clouds of ATLAS

ATLAS cloud jobs (Jan. 2014 – present)

- 61% Single-core production
- 33% Multi-core production
- 3% User analysis
IaaS Resource Management

- Primarily using HTCondor + Cloud Scheduler
  - See talk “HEP cloud production using the CloudScheduler/HTCondor Architecture”
  - In operation for ATLAS for > 3 years
- Dynamic Condor slots to handle arbitrary job requirements
  - e.g. single-core, multi-core, high-mem
- uCernVM image
- Contextualization using cloud-init
- Using Glint Image Management System (see poster)
Shoal
Proxy Cache “Federator”

- Shoal Server tracks squids
  - discover new ones
  - verify functionality
  - remove missing/faulty ones

- Workers find best squids
  - based on squid proximity and load

- Build a fabric of proxy caches
  - configurationless topology
  - robust
  - scalable
List of Active Squids

5 active in the last 180 seconds

<table>
<thead>
<tr>
<th>#</th>
<th>Hostname</th>
<th>Public IP</th>
<th>Private IP</th>
<th>Bytes Out</th>
<th>City</th>
<th>Country</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Last Received</th>
<th>Alive</th>
<th>Verified</th>
<th>Access Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>squid-test01.gridpp.rl.ac.uk</td>
<td>130.246.183.249</td>
<td></td>
<td>0 kB/s</td>
<td>Appleton</td>
<td>United Kingdom</td>
<td>51.7</td>
<td>-1.35</td>
<td>7s</td>
<td>42h40m43s</td>
<td>✓</td>
<td>Global</td>
</tr>
<tr>
<td>2</td>
<td>kraken01.westgrid.ca</td>
<td>206.12.48.240</td>
<td>172.22.2.25</td>
<td>809 kB/s</td>
<td>Vancouver</td>
<td>Canada</td>
<td>49.2836</td>
<td>-123.1041</td>
<td>10s</td>
<td>107h49m9s</td>
<td>✓</td>
<td>Global</td>
</tr>
<tr>
<td>3</td>
<td>atlasca3.triumf.ca</td>
<td>142.90.110.88</td>
<td></td>
<td>0 kB/s</td>
<td>Vancouver</td>
<td>Canada</td>
<td>49.2765</td>
<td>-123.2177</td>
<td>20s</td>
<td>16h52m3s</td>
<td>✓</td>
<td>Global</td>
</tr>
<tr>
<td>4</td>
<td>atlas-squid.cern.ch</td>
<td>128.142.200.105</td>
<td></td>
<td>0 kB/s</td>
<td>Geneva</td>
<td>Switzerland</td>
<td>48.1958</td>
<td>6.1481</td>
<td>22s</td>
<td>16h19m59s</td>
<td>✗</td>
<td>Global</td>
</tr>
<tr>
<td>5</td>
<td>t2software03.physics.ox.ac.uk</td>
<td>163.1.6.175</td>
<td></td>
<td>35 kB/s</td>
<td>Oxford</td>
<td>United Kingdom</td>
<td>51.75</td>
<td>-1.25</td>
<td>26s</td>
<td>16h18m56s</td>
<td>✓</td>
<td>Global</td>
</tr>
</tbody>
</table>

**PAC Interface**

```c
function FindProxyForURL(url, host) {
    return "PROXY http://atlasca3.triumf.ca:3128;";
    PROXY http://kraken01.westgrid.ca:3128;
    PROXY http://t2software03.physics.ox.ac.uk:3128;
    PROXY http://squid-test01.gridpp.rl.ac.uk:3128;
    PROXY http://atlas-squid.cern.ch:3128; DIRECT";
}
```

**JSON REST Interface**

```json
{  "load": 0,  "domain_access": true,  "squid_port": 3128,  "global_access": true,  "verified": true,  "last_active": 1424904480.149829,  "created": 1424603679.411669,  "external_ip": null,  "geo_data": {    "city": "Vancouver",    "region_name": "BC",    "area_code": 0,    "timezone": "America/Vancouver",    "data_code": 0,    "metric_code": null,    "country_code": "CAN",    "latitude": 49.2765,    "postal_code": "V5J",    "longitude": -123.217700000000001,    "country_name": "Canada",    "continent": "NA"  },  "hostname": "atlasca3.triumf.ca",  "public_ip": "142.90.110.88",  "private_ip": null,  "max_load": 122000,  "distance": 0.00239483111931116886}
```

- [github.com/hep-gc/shoal](http://github.com/hep-gc/shoal)
- [CHEP 2013 Poster](http://shoal.heprc.uvic.ca)
Grid/Cloud Site Performance Comparison

- Used Hammercloud stress tests
- Ran continuous stream of jobs on each site for 24 hours
- Using a single input dataset on the grid storage

Success rate similar. Grid site processed four times more jobs
• Software setup time
  – Relies on CVMFS cache and Squid proxy

• Data stage-in time
  – Remote vs. local storage access
HS06 Benchmarking Study

• Commercial clouds provide on-demand scalability
  – e.g. urgent need for beyond pledged resources
• But how cost-effective are they?
• Comparison to institutional clouds
ATLAS Preliminary

Cloud Benchmarking

VM Type

GCE; Standard
n1-standard-1
n1-standard-2
n1-standard-4
n1-standard-8
n1-standard-16

GCE; High CPU
n1-highcpu-2
n1-highcpu-4
n1-highcpu-8
n1-highcpu-16

Amazon EC2
m3.large
m3.xlarge
m3.2xlarge

c2.large

cc-west
c2.large
c4.large
c8.large
c16.large

cc-east
c4.large
c8.large
c16.large

HS06 Score / Number of vCPUs
Cloud Monitoring

- VM management becomes the responsibility of the VO
- Basic monitoring is required
  - Detect and restart problematic VMs
  - Identify “dark” resources (deployed but unusable)
  - Can identify inconsistencies in other systems through cross-checks
- Common framework for all VOs
- Implemented with Ganglia
- http://agm.cern.ch/
Cloud Accounting

- Provider-side: commercial invoice for resources delivered
- Consumer-side: record resources consumed
- Need to cross-check invoice against recorded usage!
Sim@P1

- 2nd-most productive site in 2014
  - 64M CPU hours, 1.7B MC events
- Used for LHC stops > 24h
- Fast automated switching via web GUI for shifters
  - TDAQ to Sim@P1: 1h (check Nova DB, start VMs)
  - Sim@P1 to TDAQ: 12m (graceful VM shutdown, update DB)
  - Emergency switch to TDAQ: 100s (immediate termination)