HTCondor at HEPiX, WLCG and CERN – Status and Outlook

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22 May 2018

CERN material courtesy by Ben Jones
HEPiX

- From our Web site https://www.hepix.org:
  “The HEPiX forum brings together worldwide Information Technology staff, including system administrators, system engineers, and managers from the High Energy Physics and Nuclear Physics laboratories and institutes, to foster a learning and sharing experience between sites facing scientific computing and data challenges.”

- Workshops: Twice per year, one week each
  - Open attendance, everybody (including non-HEP!) welcome
  - Plenaries only, no programme committee, no proceedings
  - Honest exchanges about experience, status and plans
  - Workshop last week at Physics Department, UW Madison
  - Next workshops: 08 – 12 October 2018 Barcelona (Spain); spring 2019 San Diego (CA); autumn/fall 2019 Amsterdam (The Netherlands)

- Working groups, board, co-chairs (HM, Tony Wong/BNL)
HTCondor often mentioned at HEPiX in site reports and dedicated presentations (computing track)

Clear consolidation: Previously plethora of solutions (PBS/Torque, *GridEngine, LSF, …), most sites now on (or moving to) HTCondor or (HPC only) Slurm

Similarly: CEs for grid submission: Consolidating on HTCondor CE (with HTCondor) and ARC-CE (with HTCondor and Slurm)

Big topic recently: analysis job submission from Jupyter notebooks

WLCG in December 2017 at pledging sites: 211M HS06 days (30% over pledges), equivalent to 700k average today’s cores

- Significant contributions from non-pledging sites, volunteers, … (“opportunistic usage”)
## HTCondor in WLCG

<table>
<thead>
<tr>
<th>Site</th>
<th>Batch scheduler</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERN</td>
<td>See later</td>
</tr>
<tr>
<td>BNL</td>
<td>HTCondor</td>
</tr>
<tr>
<td>FNAL</td>
<td>HTCondor</td>
</tr>
<tr>
<td>KIT</td>
<td>HTCondor</td>
</tr>
<tr>
<td>Nordic T1</td>
<td>Slurm</td>
</tr>
<tr>
<td>CC-IN2P3</td>
<td>UGE, considering HTC</td>
</tr>
<tr>
<td>RAL</td>
<td>HTCondor</td>
</tr>
<tr>
<td>Nikhef</td>
<td>PBS</td>
</tr>
<tr>
<td>PIC</td>
<td>Migration to HTC 60% done</td>
</tr>
<tr>
<td>CNAF</td>
<td>Migration to HTC started</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site</th>
<th>Batch scheduler</th>
</tr>
</thead>
<tbody>
<tr>
<td>US T2</td>
<td>Mostly HTCondor</td>
</tr>
<tr>
<td>LBNL</td>
<td>Slurm</td>
</tr>
<tr>
<td>IHEP</td>
<td>HTCondor, (Slurm)</td>
</tr>
<tr>
<td>DESY</td>
<td>HTCondor, (Slurm)</td>
</tr>
<tr>
<td>FZU</td>
<td>Migration to HTCondor ongoing</td>
</tr>
<tr>
<td>U Tokyo</td>
<td>LSF</td>
</tr>
<tr>
<td>CSCS</td>
<td>Slurm</td>
</tr>
<tr>
<td>GRIF</td>
<td>HTCondor</td>
</tr>
<tr>
<td>CoEPP</td>
<td>HTCondor</td>
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</tbody>
</table>

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CERN: Previously at HTCondor week…

- At the 2016 HTCondor week, we had a production setup
- Since then we have increased in size, and also the scope of what we’re asking the batch system to do
- The rest of this talk will cover where we are with our deployment, the evolution of our use cases, and some future work
Batch Capacity

<table>
<thead>
<tr>
<th>System</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTCondor</td>
<td>185000</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>LSF</td>
<td>75000</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>LSF</td>
<td>46000</td>
</tr>
</tbody>
</table>

2016: HTCondor, 20000

2018: HTCondor, 185000

Cores

22 May 2018
Last 2 years
(on fifemon since 2016 Condor Week)
Migration status

- Grid workload migrated entirely
- No technical issues preventing rest of capacity moving to HTCondor
- Remaining use cases are some Tier-0 reconstruction & calibration that will move at end of Run 2 (end 2018)
CERN Data Centre: Private Openstack Cloud

- More Than 300,000 cores
- More Than 350,000 physics jobs per day
- Batch: ~77% Of cloud capacity

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## Two submission use cases

<table>
<thead>
<tr>
<th></th>
<th>Grid</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authentication</strong></td>
<td>X509 Proxy</td>
<td>Kerberos</td>
</tr>
<tr>
<td><strong>Submitters</strong></td>
<td>LHC experiments, COMPASS, NA62, ILC, DUNE…</td>
<td>Local users of experiments, Beams, Theorists, AMS, ATLAS Tier-0</td>
</tr>
<tr>
<td><strong>Submission method</strong></td>
<td>Submission frameworks: GlideinWMS, Dirac, PanDA, AliEn</td>
<td>From condor_submit by hand, to complicated DAGs, to Tier-0 submit frameworks.</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Grid protocols. SRM, XRootD…</td>
<td>AFS, EOS</td>
</tr>
</tbody>
</table>
Compute Growth Outlook

- Resources looking very tight for Run 3
- No new datacenter & exiting Wigner
- Requirement to maximize the use of any compute we can, wherever it is acquired.
HTCondor Infra in numbers

- 2 pools
  - Share + extras: 155k cores
  - Tier-0 (CMS and ATLAS): 30k cores
- 13 + 2 production htcondor-ce
- 10 + 1 production ”local” schedds
- Main shared pool:
  - 3 negotiators (2 normal + 1 for external cloud resources)
  - 15 sub collectors
- Max 10k jobs per scheddd
Multiple resource types

- Standard shared batch farm
- Resources dedicated to one group
  - Special requirements, such as Tier-0 activity
  - Experiments that “own” their own resources, but want central IT service to run it
- Opportunistic resources internally
  - Using spare CPU slots on Disk servers (BEER)
- Opportunistic resources externally
  - XBatch / HNScience Cloud
- Special machines (big memory)
Targeting specific resources

- Beyond specifying just resource characteristics (cpu, memory etc) we have jobs targeting different resources
- Accounting Group matches jobs to dedicated resources
- We use job router / job transforms to provide special routes to special resources like Cloud or BEER
  - Experiments’ monitoring is based on concept of “sites” with particular JDL, and for special resources they want extra observability
BEER

• **Batch on EOS Extra Resources**
• CERN has typically bought same hardware for batch and disk servers
• Disk servers don’t use much CPU (or, for physics workload) utilize much filesystem cache
• Familiar to any of you that were at HEPiX last week – see HEPiX talk for performance analysis
  https://indico.cern.ch/event/676324/contributions/2981816/
BEER Integration

- Aim: limit HTCondor & jobs to under resource limits disk server can afford
- Minimize config & OS requirement of host disk server
- HTCondor and jobs managed by CGroup with max memory, limit CPUs and I/O
- Jobs in Docker universe to abstract disk server environment
- Drain / evacuate procedures for storage admins!
Challenge is public procurement of commercial cloud resources

- **1st Cloud Procurement**
  - **End:** 31st of March 2015
  - ATLAS simulation jobs
  - Single core VMs
  - Up to 3k VMs for 45 days
  - Sponsored Account

- **2nd Cloud Procurement**
  - **End:** 18th of Dec. 2015
  - Target all VOs, simulation jobs
  - 4-core VMs, O(1000) instances

- **3rd Cloud Procurement**
  - **End:** 30th of Nov. 2016
  - Provided by OTC IaaS
  - 4-core VMs, O(1000) instances
  - 500TB of central storage (DPM)
  - 1k public IPs through GÉANT

**1st Aug.**
- **End:** 30th of Nov. 2016
- Provided by OTC IaaS
- 4-core VMs, O(1000) instances
- 500TB of central storage (DPM)
- 1k public IPs through GÉANT

**2nd Mar.**
- **End:** 31st of March 2015
- ATLAS simulation jobs
- Single core VMs
- Up to 3k VMs for 45 days
- 1st Cloud Procurement

**6th Nov.**
- **End:** 18th of Dec. 2015
- Target all VOs, simulation jobs
- 4-core VMs, O(1000) instances
- 2nd Cloud Procurement

**23rd Mar.**
- **End:** 30th of Nov. 2015
- Sponsored Account
- "evaluation of Azure as an IaaS"
- Any VO, any workload
- Targeting multiple DCs: Iowa, Dublin and Amsterdam

**20th Nov.**
- **End:** 13th of May 2016
- Agreement between IBM and CERN
- CERN PoC to evaluate:
  - Resource provisioning
  - Network configurations
  - Compute performance
- Transparent extension of CERN’s T0
Cloud

• Procurement so far has been for flat capacity rather than burst

• HTCondor integration 1.0:
  • Configuration Management to create VMs with certificates to log into pool
  • Experiments again want to observe / monitor as a separate site
  • Separate negotiator, specific htcondor-ce route to match jobs requesting cloud with cloud workers
Future: kubernetes

- Kubernetes to manage HTCondor has a number of potential wins
  - kubefed federation means we can span kubernetes pods across clouds
  - At kubecon demoed federation from CERN to T-Systems, have integrated GCE, Azure, AWS, CERN…
    https://kccnceu18.sched.com/event/Duoa
  - Simplify requirements for cloud: just need a container engine or just IAAS
  - Internally can use bare metal managed by cloud team, container layer batch team
  - No “virtualization overhead”, no hypervisor tax
  - Potential to ”hyperconverge” data, services, batch
kubefed init fed --host-cluster-context=condor-host
...

Host

Sched

Collector

Negotiator
kind: DaemonSet

... 
hostNetwork: true
containers:
- name: condor-startd
  image: /cloud/condor-startd
  command: ['"/usr/sbin/condor_startd"', '-f']
securityContext:
  privileged: true
livenessProbe:
  exec:
    command:
    - condor_who

kubefed init fed --host-cluster-context=condor-host
...

kubefed join --context fed tsystems \
--host-cluster-context condor-host \
--cluster-context tsystems
Conclusions

- Demands on compute not getting easier
- We need to be able to deploy real workload on any resources we can get our hands on
- HTCondor continues to help us expand and meet these demands
- More technical detail available at European HTCondor workshop 04-07 September 2018 at RAL (and next HTCondor week hopefully)
Questions?