The Scheduling Strategy and Experience of IHEP HTCondor Cluster

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On behalf of scheduling group of

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Outline

1. Migration to HTCondor
2. Scheduling Policy to HTCondor
3. Works Designed and Developed
4. Problems We Met
5. Summary and Future Work

The Migration to HTCondor

- Motivation
  - PBS had been used at IHEP for more than 10 years
  - Limited Scalability and growing resources and users
    - ~10,000+ job slots and 20,000+ jobs: Performance bottleneck
- Migration to HTCondor: Better performance and active community
- Migration step by step with risk control
  - Jan, 2015 : ~ 1,100 CPU cores
  - May, 2016: ~ 3,500 CPU cores
  - Dec, 2016: ~ 11,000 CPU cores

Current Status

- Architecture
  - 28 submitting nodes
  - 2 scheduler machine (local cluster, virtual cluster)
  - 2 central manager (local cluster, virtual cluster)
  - ~ 10,000 physical CPU cores + an elastic number of virtual slots
- Jobs
  - Avg 100,000 jobs/day;
  - 60,000 jobs in queue at peak time
  - Serial and single-core jobs

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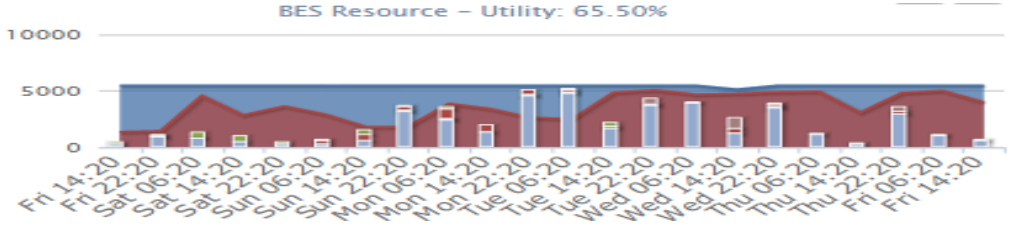
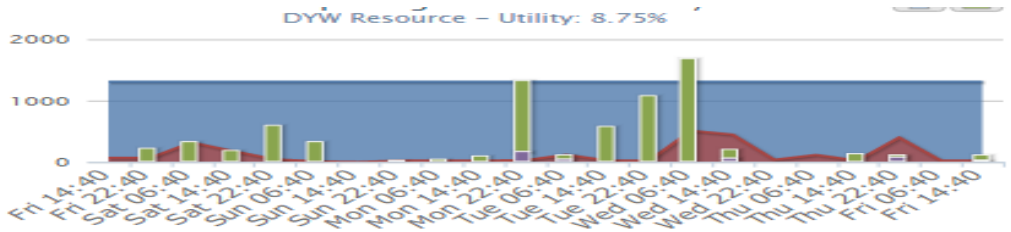
Resource Divided at PBS Cluster

- Several HEP experiments supported
  - BES, Daya Bay, Juno, Lhaaso, HXMT etc.
  - Resources are funded and dedicated for different experiments
  - No resource sharing among experiments
  - 55 jobs queues with group permission limits set at PBS
- Low resource utility
  - Coexistence busy queues and free resources



Busy Group



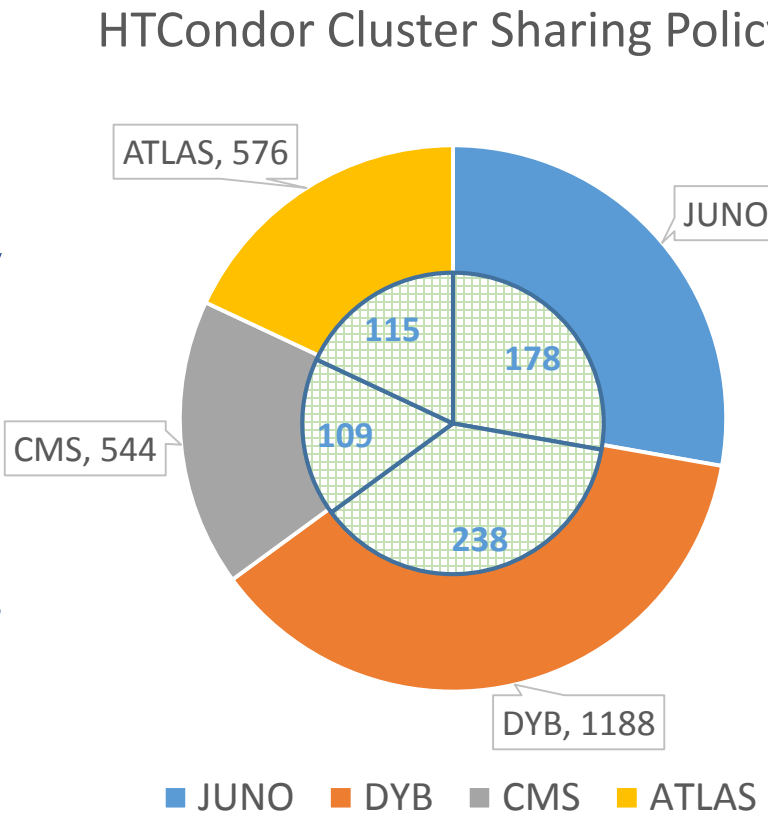
Idle Group

Scheduling Strategy at HTCondor Cluster

- Resource sharing
  - Break the resource separation
  - Busy groups can occupy more resource from the resource of idle groups
- Fairness guarantee
  - Peak computing requirements from different experiment usually happened at different time period
  - Jobs from idle group have high priority
  - The more resource the experiment contribute to share, the more its jobs can be scheduled to run

Resource Sharing at HTCondor

- Based on job slots (mainly CPU cores)
- As a first step, resources are partially shared
- Some exclusive resources are kept by experiments own
  - Only run jobs from the resource owner
- Sharing resource pool
  - Resource contributed by all experiments
  - Slot can accept for jobs from all experiments
  - At least 20% slots are shared by each experiment
  - encourage experiments to share more resources



The exclusive and shared slots of different groups

Fairness and Priority

- Scheduling preference
  - Jobs prefers to run on exclusive slots of its own experiment
  - The shared slots are kept for busy experiments
- Experiemnt quota
  - Users from the experiment are in the same linux group
  - The initial group quota is set to the amount of real resources from experiments
  - The quota can be exceeded if there are idle slots in the sharing pool
- Group priority and User priority
  - Group priority is correlated to the group quota and the group slots occupancy
  - User Priority is effective inside same group users

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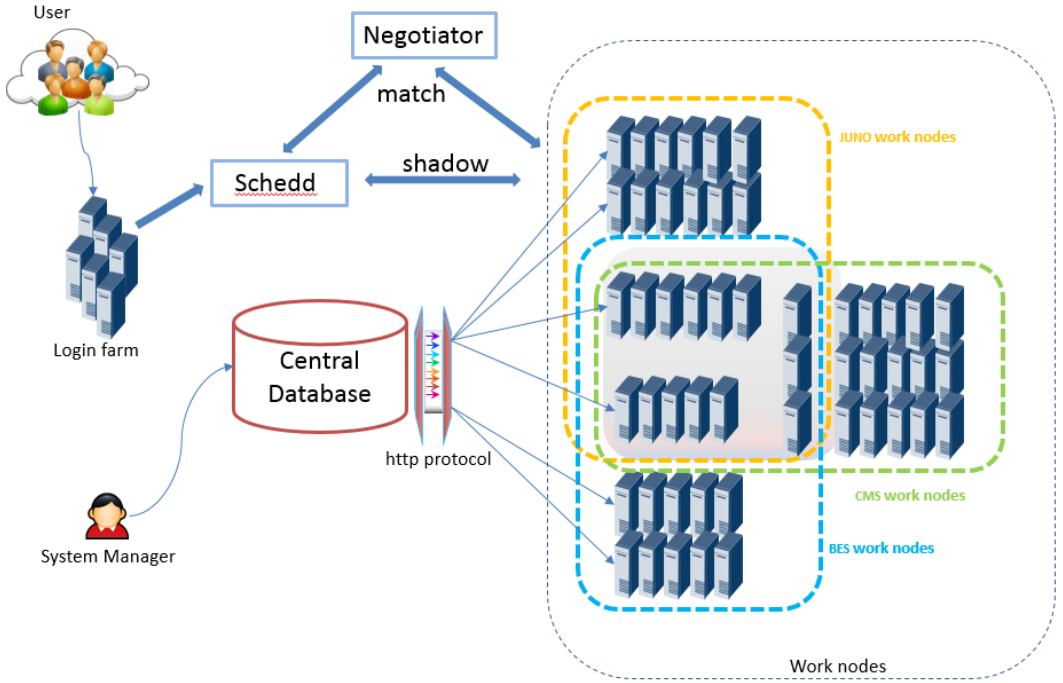
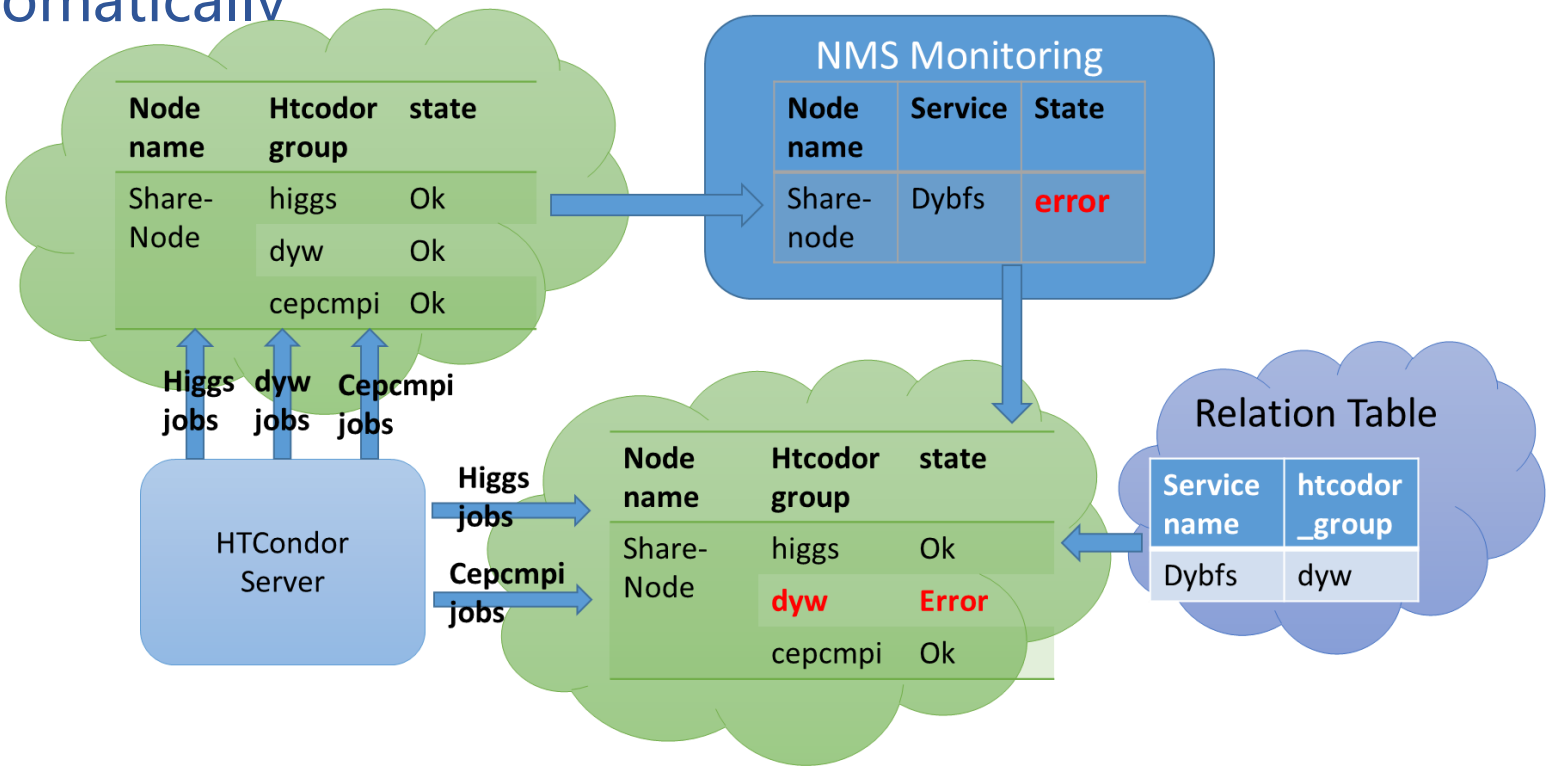
Central Controller

- The central control of groups, users and work nodes
  - All information is collected and saved into Central Database
  - Necessary information is updated and published to relative services
  - Work nodes update its configuration via httpd periodically



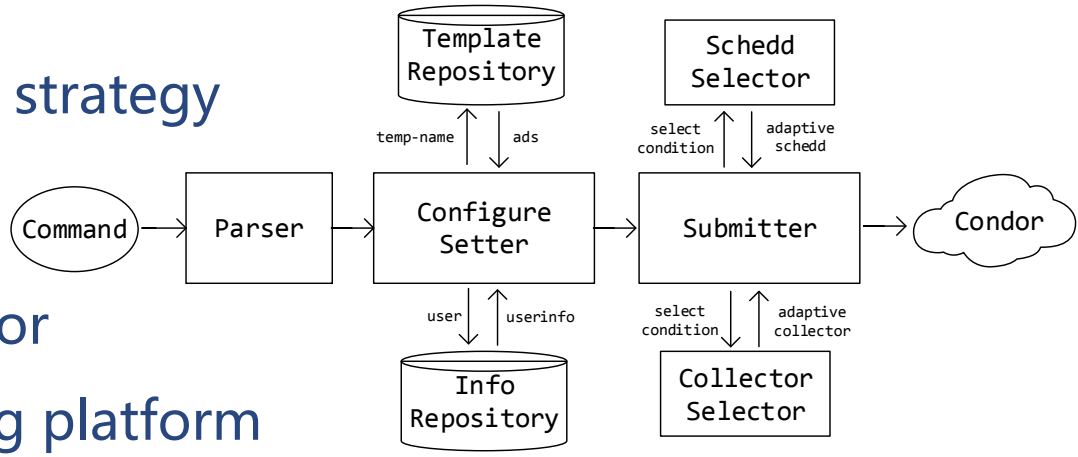
Error Detection and Recovery

- Health status of all workers are collected from monitoring system and saved into Central Database
- Central controller updates work noworkers’ attributes automatically



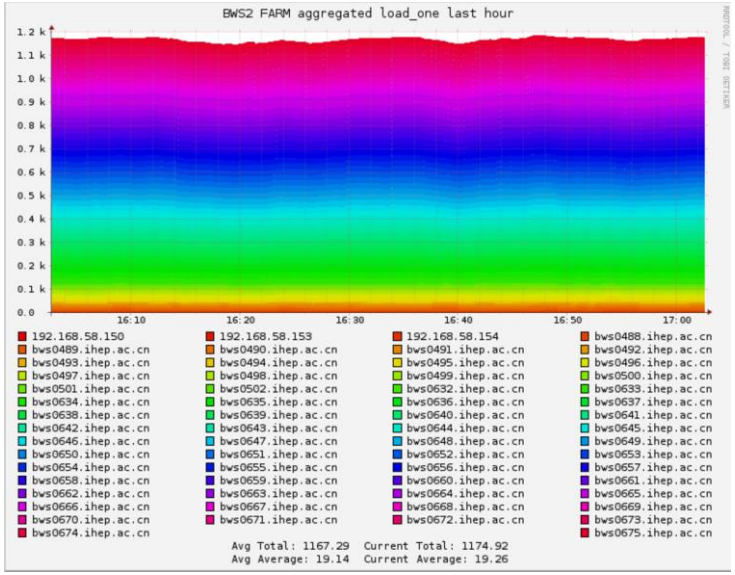
The Toolkit: hep_job

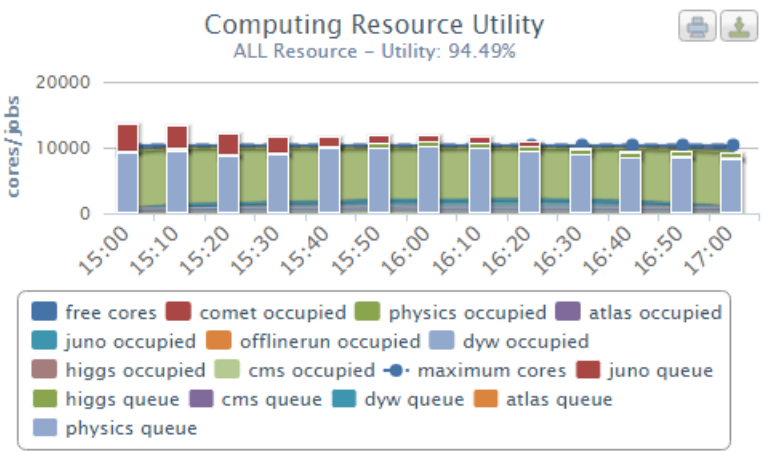
- Motivation
  - Smooth migration from PBS to HTCondor for users
  - Simplify users' work
  - Help to achieve our scheduling strategy
- Implementation
  - Base on python API of HTCondor
  - Integrated with IHEP computing platform
  - Server name, group name
  - Several Jobs template according the experiments requirements

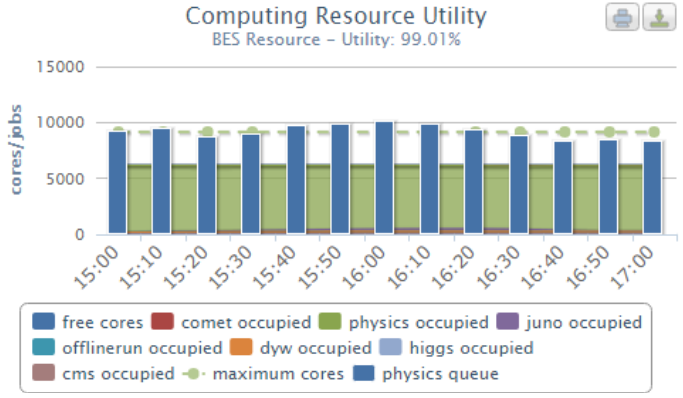


Job Monitoring

- Queueing and running statistics
  - The overall clusters
  - Each group/experiment
- The exclusive and sharing resource statistics
- Nagios and Ganglia





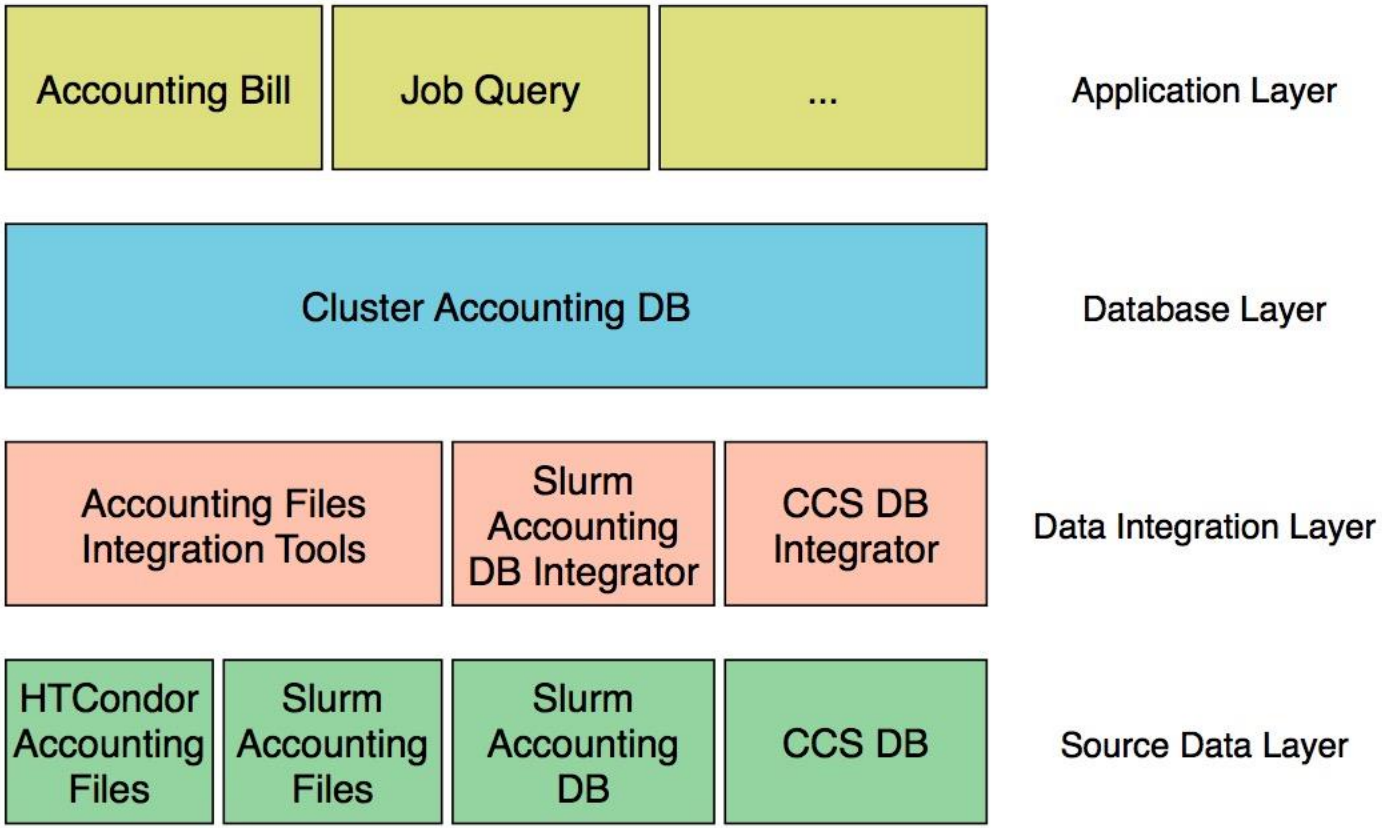


Status Summary For All Host Groups

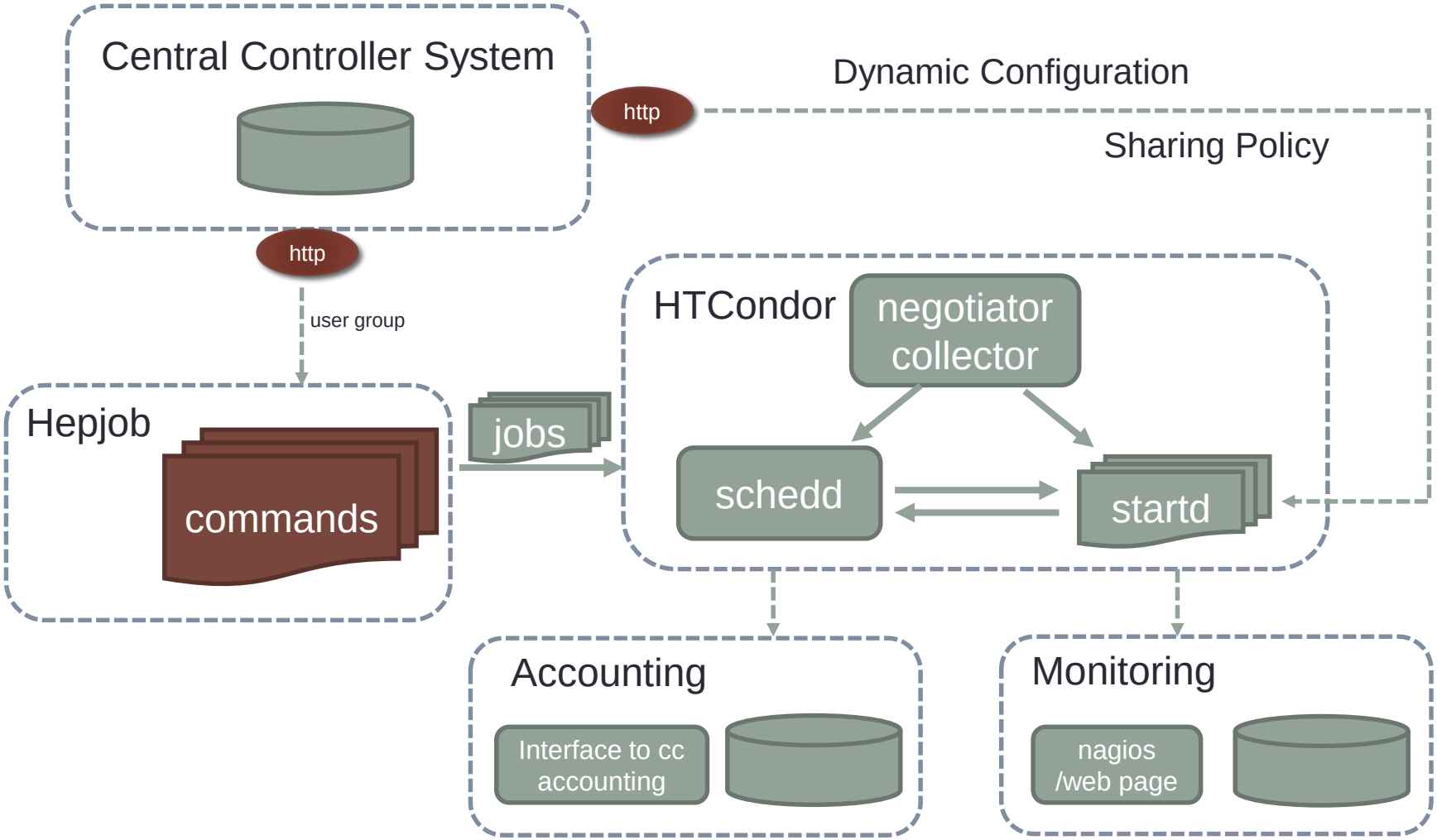
Host Group	Host Status Summary	Service Status Summary
AMS CWS HXMT节点 负责人，闫晓飞 (AMS-Servers)	150 UP	1975 OK 2 WARNING : 2 Unhandled 2 CRITICAL : 2 Unhandled
AWS计算节点 负责人，系统组值班人员 (AWS-servers)	43 UP	551 OK 1 WARNING : 1 Unhandled
bws dbws计算节点 负责人，系统组值班人员 (BWS-Servers)	470 UP	7033 OK 5 UNKNOWN : 5 Unhandled 1 CRITICAL : 1 Unhandled
备份服务器-魏秋玲 (Bak-Servers)	9 UP	25 OK
BIO计算结点负责人系统组值班人员 (Bio-servers)	29 UP	347 OK
计算中心节点cac ccib map nano 负责人，系统组值班人员 (CC-Servers)	46 UP	460 OK
云计算服务器-崔勇 (Cloud-Servers)	9 UP	10 OK
数据库服务器 (DB_SERVER)	9 UP	9 OK
DWS计算节点 负责人，系统组值班人员 (DWS-Servers)	106 UP	1483 OK
数据服务器 负责人 杜国红 杨敏 (Data-Servers)	8 UP	12 OK
GPU 负责人 文硕频6067 (GPU-Servers)	122 UP	1503 OK
存储服务器 (GRASS-Servers)	15 UP	45 OK
负责人 系统组值班人员 (Gluster-Servers)	13 UP	78 OK
高能所网格节点 lwn cac (IHEP-Grid)	67 UP	444 OK 2 CRITICAL : 2 Unhandled
江门中微子计算节点 (JNWS-Servers)	48 UP	506 OK
作业管理服务器pbs condor slurm (Job-servers)	5 UP	10 OK
登录节点 负责人 杜国红 杨敏 (Login-Servers)	70 UP 1 DOWN : 1 Unhandled	866 OK 23 CRITICAL : 11 Unhandled 12 on Problem Hosts

Global Accounting

- Detailed accounting to each group and each user
- Weighting slots with slow/fast CPU, Memory, Disk, etc.



Put All Together



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Problems We Met – dishonest user

- Claimed with other group member to obtain more job slots
- Running sshd daemon at work nods
  - ssh to work nodes without password
  - run big MPI task from login node secretly
  - occupied more cpu cores than the slots declaimed in job
- How to deal with
  - Add group priority check at wrapper of work nodes
  - Zombie process check deployed at work nodes to kill the process which does not belong to jobs running on the work node

Problem We Met – job hung

- Sched daemon can not be connected in a short time suddenly
- Jobs are hung and re-queued unexpectedly
- Reason:
  - Default open file limit: 1024
- How to deal with
  - Increase the system limit
  - Restart sched process

```
03/10/17 17:56:47 (pid:1105883) Started shadow for job
7339826.0 on slot1@bws0472.ihep.ac.cn
<192.168.57.232:6795?addrs=192.168.57.232-6795> for
physics.mahl, (shadow pid = 3809619)
03/11/17 01:50:56 (pid:1105883) ERROR: Child pid 3809619
appears hung! Killing it hard.
03/11/17 01:50:56 (pid:1105883) Shadow pid 3809619
successfully killed because it was hung.
03/11/17 01:50:56 (pid:1105883) Shadow pid 3809619 for job
7339826.0 exited with status 4
03/11/17 01:50:56 (pid:1105883) ERROR: Shadow exited with
job exception code!
```

Problems We Met – sched owner changed

- The owner of “condor_sched” changed from condor to normal user
- Reason:
  - Disk mounted at Sched server inaccessible
- How to deal with:
  - Disk check added and report to monitoring
  - Version upgrade consideration

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Summary and Future Work

- Summary
  - The resource utility has been significantly improved with the resource sharing policy
  - We implemented a number of tools to enhance the system interaction and robustness
- Future work
  - Automatically tuning the resource sharing ratio according to the overloads of each group
    - The integration of Job Monitoring and Central Controller
  - HTCondor sites union

Thank you !

Question?