Matchmaker Policies: Users and Groups

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HTCondor scheduling policy

- So you have some resources…

  … how does HTCondor decide which job to run?

- The admin needs to define a policy that controls the relative priorities

- What defines a “good” or “fair” policy?

First Things First

- HTCondor does not share the same model of, for example, PBS, where jobs are placed into a first-in-first-out queue

- It instead is based around a concept called "Fair Share"
  - Assumes users are competing for resources
  - Aims for long-term fairness

Spinning Pie

- Available compute resources are “The Pie”
- Users, with their relative priorities, are each trying to get their “Pie Slice”
- But it’s more complicated: Both users and machines can specify preferences.
- Basic questions need to be answered, such as “do you ever want to preempt a running job for a new job if it’s a better match”? (For some definition of “better”)

Spinning Pie

- First, the Matchmaker takes some jobs from each user and finds resources for them.

- After all users have got their initial “Pie Slice”, if there are still more jobs and resources, we continue “spinning the pie” and handing out resources until everything is matched.

Relative Priorities

- If two users have the same relative priority, then over time the pool will be divided equally among them.
- Over time?
- Yes! By default, HTCondor tracks usage and has a formula for determining priority based on both current demand and prior usage
- However, prior usage “decays” over time

Pseudo-Example

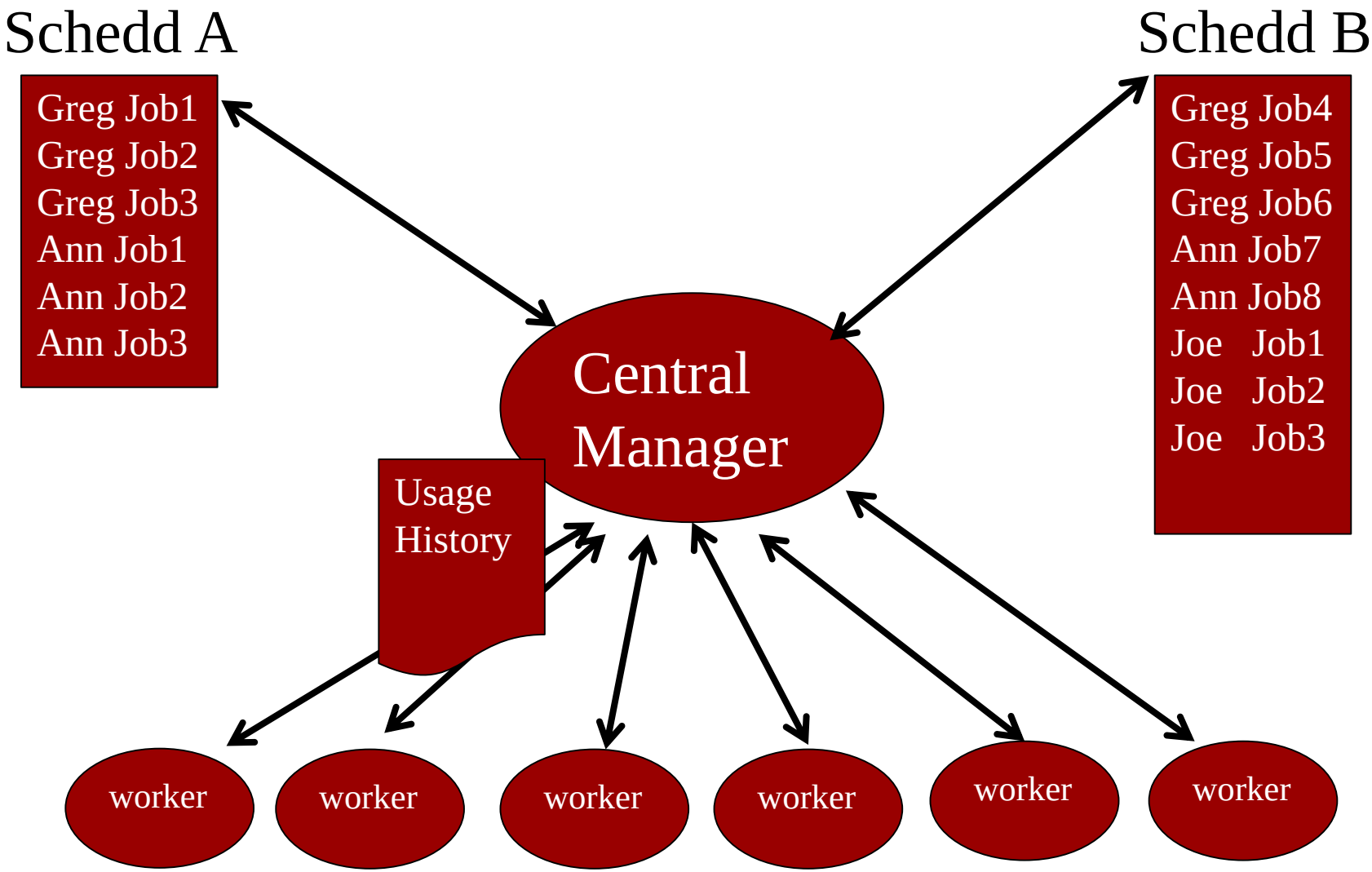
- Example: (A pool of 100 cores)
- User ‘A’ submits 100,000 jobs and 100 of them begin running, using the entire pool.
- After 8 hours, user ‘B’ submits 100,000 jobs

- What happens?

Pseudo-Example

- Example: (A pool of 100 cores)
- User ‘A’ submits 100,000 jobs and 100 of them begin running, using the entire pool.
- After 8 hours, user ‘B’ submits 100,000 jobs
- The scheduler will now allocate MORE than 50 cores to user ‘B’ because user ‘A’ has accumulated a lot of recent usage
- Over time, each will end up with 50 cores.

Overview of Condor Architecture



Negotiator metric: User Priority

- Negotiator computes, stores the user prio

- View with **`condor_userprio` tool**
- Inversely related to machines allocated (lower number is better priority)
  - A user with priority of 10 will be able to claim twice as many machines as a user with priority 20

What's a user?

- Bob in schedd1 same as Bob in schedd2?
- If have same UID_DOMAIN, they are.

- We'll talk later about other user definitions.

- Map files can define the local user name

User Priority

- (Effective) User Priority is determined by multiplying two components

- Real Priority * Priority Factor

Real Priority

- Based on actual usage
- Starts at 0.5
- Approaches actual number of machines used over time
  - Configuration setting **`PRIORITY_HALFLIFE`**
  - If PRIORITY_HALFLIFE = +Inf, no history
  - Default one day (in seconds)
- Asymptotically grows/shrinks to current usage

Priority Factor

- Assigned by administrator
  - Set/viewed with **`condor_userprio`**
  - Persistently stored in CM
- Defaults to 1000 (**`DEFAULT_PRIO_FACTOR`**)
- Allows admins to give unequal prio to different users
- “Nice user”s have Prio Factors of 10,000,000,000

condor_userprio

- Command usage:

```
condor_userprio
```

```
                                     Effective   Priority
User Name                            Priority     Factor   In Use (wghted-hrs) Last Usage
---------------------------------------------- --------- ------ ------------ ----------
lmichael@submit-3.chtc.wisc.edu          5.00      10.00      0         16.37    0+23:46
blin@osghost.chtc.wisc.edu               7.71      10.00      0       5412.38    0+01:05
osgtest@osghost.chtc.wisc.edu           90.57      10.00     47      45505.99      <now>
cxiong36@submit-3.chtc.wisc.edu        500.00    1000.00      0          0.29    0+00:09
ojalvo@hep.wisc.edu                    500.00    1000.00      0     398148.56    0+05:37
wjiang4@submit-3.chtc.wisc.edu         500.00    1000.00      0          0.22    0+21:25
cxiong36@submit.chtc.wisc.edu          500.00    1000.00      0         63.38    0+21:42
```

Accounting Groups (2 kinds)

- Manage priorities across groups of users and jobs
- Can guarantee maximum numbers of computers for groups (quotas)
- Supports hierarchies
- Anyone can join any group (well…)

Accounting Groups as Alias

- In submit file
  - `Accounting_Group = group1`

- Treats all users as the same for priority
- Accounting groups not pre-defined
- Admin can enforce group membership
  - Submit transforms and submit requirements
- condor_userprio replaces user with group

Prio factors with groups

```
condor_userprio -setfactor 10 group1@wisc.edu
condor_userprio -setfactor 20 group2@wisc.edu
```

Note that you must get UID_DOMAIN correct

Gives group1 members twice as many resources as group2

Accounting Groups w/ Quota

- Must be predefined in cm's config file:

```
GROUP_NAMES = a, b, c
GROUP_QUOTA_a = 10
GROUP_QUOTA_b = 20
```

- And in submit file:

```
Accounting_Group = a
Accounting_User = gthain
```

Group Quotas

- "a" limited to 10
- "b" to 20

- Must be predefined in cm's config file:

```
GROUP_NAMES = a, b, c
GROUP_QUOTA_a = 10
GROUP_QUOTA_b = 20
```

- And in submit file:

```
Accounting_Group = a
Accounting_User = gthain
```

- Even if idle machines
- What is the unit?
  - Slot weight.
- With fair share for users within group
- Can create a hierarchy of groups, quotas

GROUP_AUTOREGROUP

- Also allows groups to go over quota if idle machines.
- “Last chance” round, with every submitter for themselves.

Rebalancing the Pool

- Match between schedd and startd can be reused to run many jobs
- May need to create opportunities to rebalance how machines are allocated
  - New user
  - Jobs with special requirements (GPUs, high memory)

How to Rematch

- Have startds return frequently to negotiator for rematching
  - `CLAIM_WORKLIFE`
  - Draining
  - More load on system, may not be necessary
- Have negotiator proactively rematch a machine
  - Preempt running job to replace with better job
  - `MaxJobRetirementTime` can minimize killing of jobs

Two Types of Preemption

- Startd Rank
  - Startd prefers new job
    - New job has larger startd Rank value
- User Priority
  - New job's user has better priority (deserves increased share of the pool)
    - New job has lower user prio value
- No preemption by default
  - Must opt-in

Negotiation Cycle

- Gets all the machine ads
- Updates user prio info for all users
- Computes pie slice for each user
- For each user, finds the schedd
  - For each job (until pie slice consumed)
    - Finds all matching machines for the job
    - Sorts the machines
    - Gives the best sorted machine to the job
- If machines and jobs left, spins pie again

Sorting Slots: Sort Levels

- Single sort on a five-value key
  - `NEGOTIATOR_PRE_JOB_RANK`
  - Job `Rank`
  - `NEGOTIATOR_POST_JOB_RANK`
  - No preemption > Startd Rank preemption > User priority preemption
  - `PREEMPTION_RANK`

Negotiator Expression Conventions

- Evaluated as if in the machine ad
  - `MY.Foo` : Foo in machine ad
  - `TARGET.Foo` : Foo in job ad
  - `Foo` : check machine ad, then job ad for Foo
- Use `MY` or `TARGET` if attribute could appear in either ad

Accounting Attributes

- Negotiator adds attributes about pool usage of job owners
- Info about job being matched
  - `SubmitterUserPrio`
  - `SubmitterUserResourcesInUse`
- Info about running job that would be preempted
  - `RemoteUserPrio`
  - `RemoteUserResourcesInUse`

Group Accounting Attributes

- More attributes when using groups
  - `SubmitterNegotiatingGroup`
  - `SubmitterAutoregroup`
  - `SubmitterGroup`
  - `SubmitterGroupResourcesInUse`
  - `SubmitterGroupQuota`
  - `RemoteGroup`
  - `RemoteGroupResourcesInUse`
  - `RemoteGroupQuota`

If Matched machine claimed, extra checks required

- **`PREEMPTION_REQUIREMENTS`**
  - Evaluated when replacing a running job with a better priority job
  - If False, don't preempt
- **`PREEMPTION_RANK`**
  - Of machines negotiator is willing to preempt, which one to prefer

No-Preemption Optimization

- `NEGOTIATOR_CONSIDER_PREEMPTION = False`
- Negotiator completely ignores claimed startds when matching
- Makes matching faster
- Startds can still evict jobs, then be rematched

Concurrency Limits

- Manage pool-wide resources
  - E.g. software licenses, DB connections
- In central manager config
  - `FOO_LIMIT = 10`
  - `BAR_LIMIT = 15`
- In submit file
  - `concurrency_limits = foo,bar:2`

Summary

- Many ways to schedule