Negotiator Policy and Configuration

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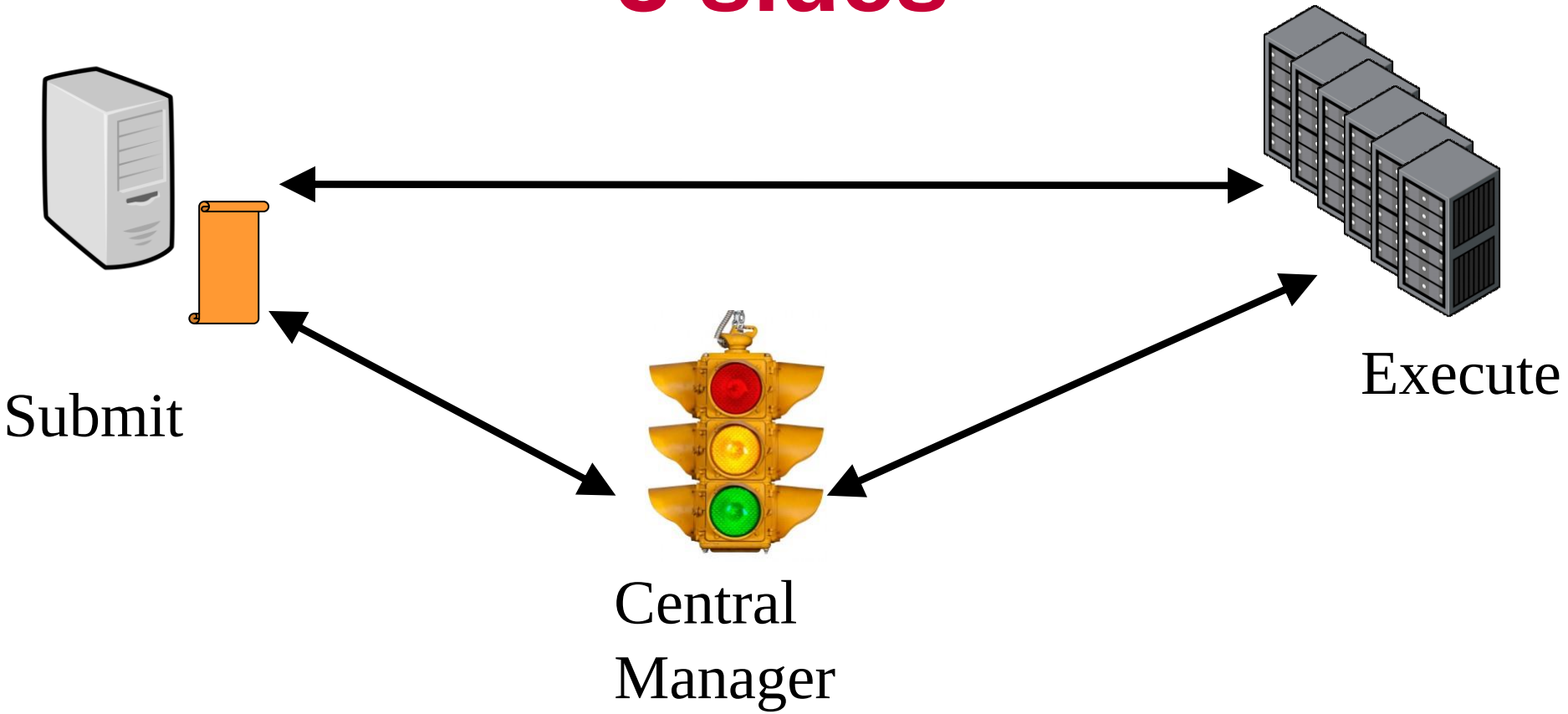
HTCondor Week 2018

Agenda

- Understand role of negotiator
- Learn how priorities work
- Learn how quotas work

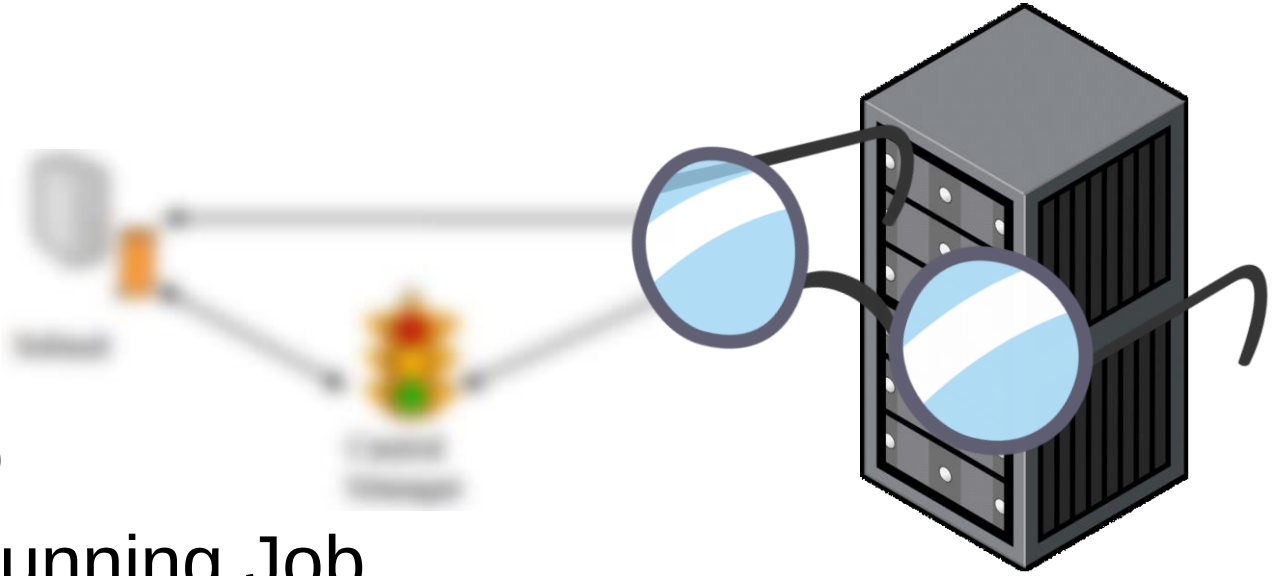
- Encourage thought about possible policies!

Overview of condor
3 sides



Startd Mission Statement

- Near sighted
- 3 inputs only:
  - Machine
  - Running Job
  - Candidate Running Job
- Knows nothing about the rest of the system!



Schedd mission

Run *jobs* on

slots the negotiator

has assigned to *submitters*.

Inputs:

All the jobs in that schedd

All the slots given to it by the negotiator

Schedd mission

Schedd Can:

- Re-use a slot for > 1 job (in succession)
- Pick which job for a user goes first

Schedd cannot:

- Reassign slots from one submitter to other

Submitter vs User

- Submitters: what are they?
- User: an OS construct
- Submitter: Negotiator construct

Negotiation Mission

Assign the *slots* of the whole pool

to *users* based on some *policy* that's 'fair'

Negotiator Inputs

- All the slots in the pool
- All the submitters in the pool
- All the submitters' priorities and quotas
- One request per submitter at a time

How the Negotiator Works

Periodically tries to:

Rebalance *%age of slots assigned to users*

Via preemption, if enabled

Via assigning empty slots if not

Negotiator is always a little out of date

Concurrency Limits

- Simplest Negotiator (+ schedd) policy
- Useful for pool wide, across user limits,

Useful Concurrency Limits:

> 100 running NFS jobs crash my server

License server only allows X concurrent uses

Only want 10 database jobs running at once

Concurrency Limits: How to Configure

add to negotiator config file (condor_reconfig needed):

```
NFS_LIMIT = 100
DB_LIMIT = 42
LICENSE_LIMIT = 5
```

Concurrency Limits: How to use

Add to job ad

```
Executable = somejob
Universe = vanilla
…
ConcurrencyLimits = NFS
queue
```

Concurrency Limits: How to use

OR

```
Executable = somejob
Universe = vanilla
…
ConcurrencyLimits = NFS:4
queue
```

Concurrency Limits: How to use

Add to job ad

```
Executable = somejob
Universe = vanilla
…
ConcurrencyLimits = NFS,DB
queue
```

Part of the picture

- Concurrency limits very “strong”
- Can throw off other balancing algorithms
- No “fair share” of limits

“Fair Share of Users”

Main Loop of Negotiation Cycle*

1. Get all slots in the pool
2. Get all ~~jobs~~ submitters in pool
3. Compute # of slots submitters should get
4. In priority order, hand out slots to submitters
5. Repeat as needed

The Negotiator as Shell Script

1. Get all slots in the pool
2. Get all ~~jobs~~ submitters in pool
3. Compute # of slots submitters should get
4. In priority order, hand out slots to submitters
5. Repeat as needed

1: Get all slots in pool

1: Get all slots in pool

```
$ condor_status
```

1: Get all slots* in pool

```
NEGOTIATOR_SLOT_CONSTRAINT = some classad expr
```

NEGOTIATOR_SLOT_CONSTRAINT

Defaults to true, what subset of pool to use

For sharding, etc.

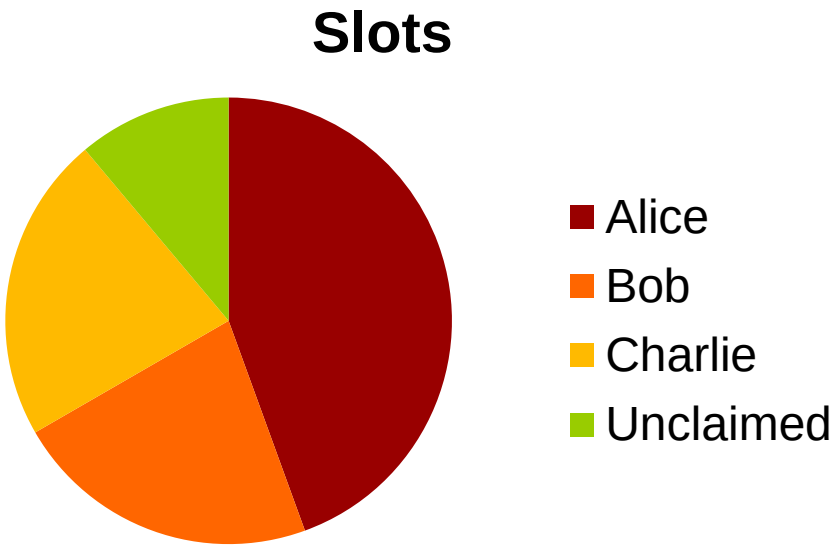
1: Get all slots in pool

```
$ condor_status -af Name State RemoteOwner
```

```
slot1@... Claimed Alice
slot2@... Claimed Alice
slot3@... Claimed Alice
slot4@... Unclaimed undefined
slot5@... Claimed Bob
slot6@... Claimed Bob
slot7@... Claimed Charlie
slot8@... Claimed Charlie
```

1: Get all slots in pool

```
$ condor_status -af Name RemoteOwner
```



2: Get all submitters in pool

```
$ condor_status -submitters
```

2: Get all submitters in pool

```
$ condor_status -submitters
```

```
Name     Machine RunningJobs IdleJobs
Alice    submit1 4                4
Bob      submit1 2              100
Charlie  submit1 2                0
Danny    submit1 0               50
```

2: Get all submitters in pool

```
$ condor_status -submitters
```

```
Name     Machine RunningJobs IdleJobs
Alice    submit1 4                4
Bob      submit1 2              100
Charlie  submit1 2                0
Danny    submit1 0               50
```

3: Compute per-user “share”

- Tricky
- Based on historical usage

3a: Get historical usage

```
$ condor_userprio -all
```

3a: Get historical usage

```
$ condor_userprio -all
```

```
UserName Effective Real      Priority  Res
         Priority Priority    Factor  in use
Alice      3100      3.1       1000      4
Bob        4200      4.2       1000      2
Charlie    1500      1.5       1000      2
Danny      8200      8.2       1000      0
```

3a: Get historical usage

$$EffectivePrio = RealPrio \text{ X } PrioFactor$$

UserName	Effective Priority	Real Priority	Priority Factor	Res in use
Alice	3100	3.1	1000	4
Bob	4200	4.2	1000	2
Charlie	1500	1.5	1000	2
Danny	8200	8.2	1000	0

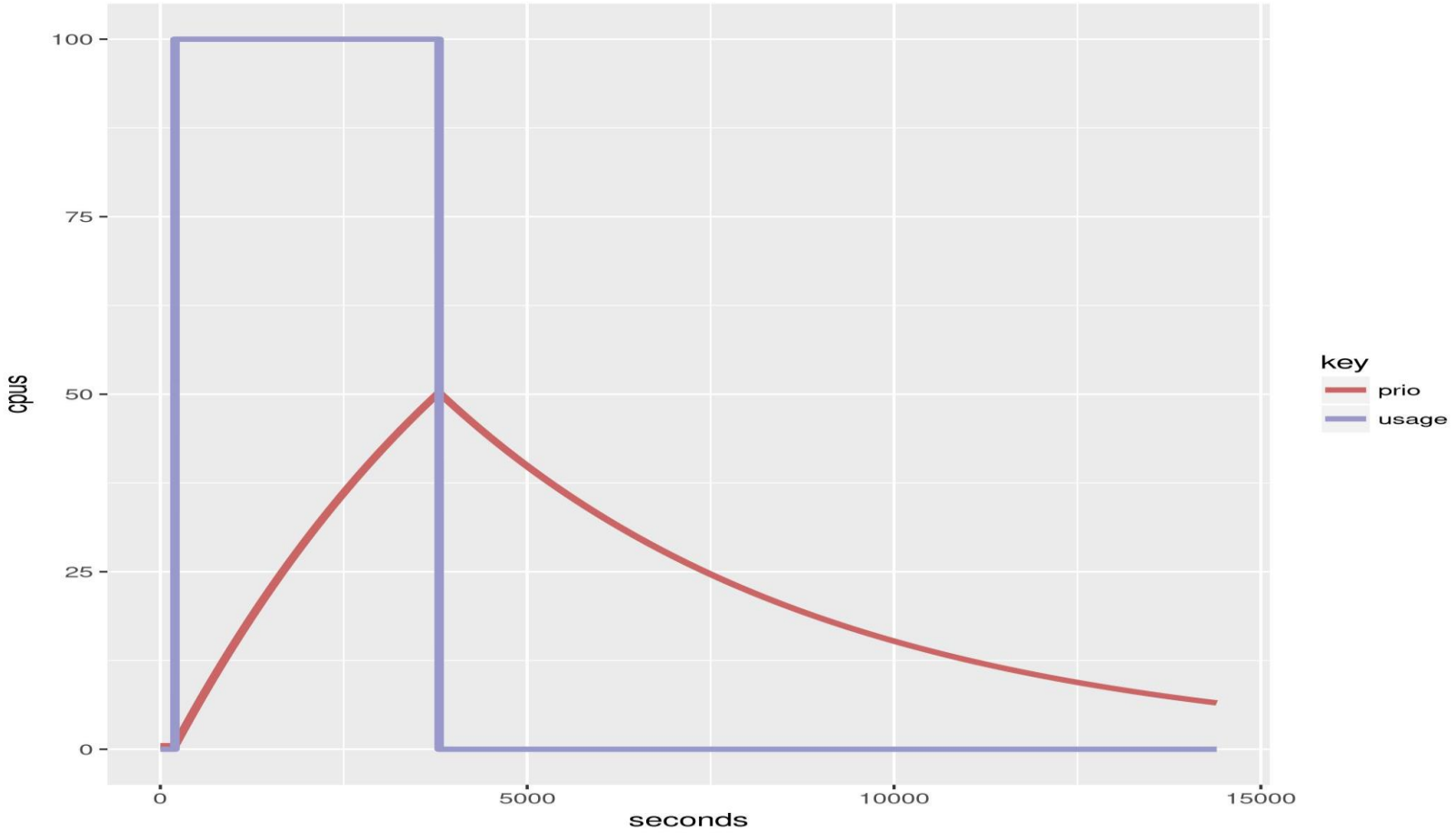
So What is Real Priority?

Real Priority is smoothed historical usage

Smoothed by `PRIORITY_HALFLIFE`

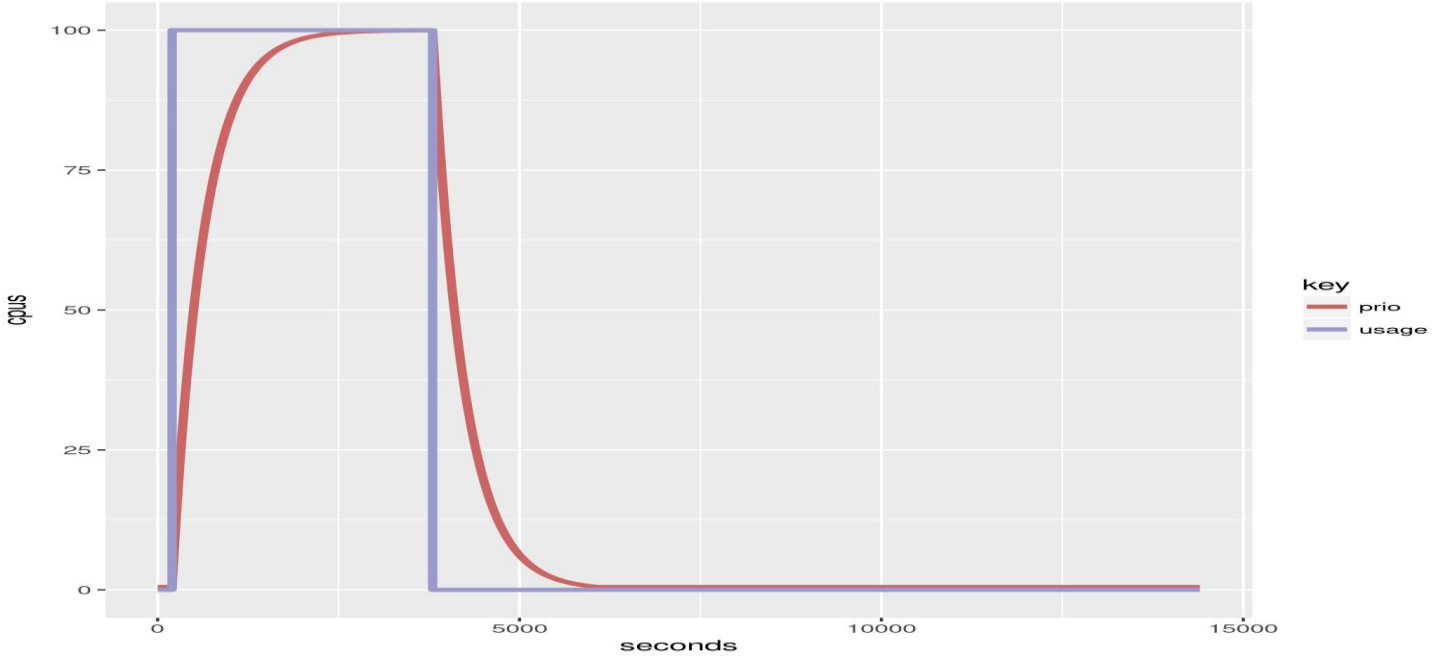
`PRIORITY_HALFLIFE` defaults 86400s (24h)

Actual Use vs Real Priority



Another PRIORITY_HALFLIFE

PRIORITY_HALFLIFE = 1



3a: Get historical usage

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$ condor_userprio -all
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Danny      8200      8.2       1000      0
```

Effective priority:

- Effective Priority is the *ratio* of the pool
  that the negotiator tries to allot to *users*

Lower is better, 0.5 is the best real priority

```
UserName Effective Real      Priority  Res
         Priority Priority   Factor  in use
Alice      1000      1.0      1000     4
Bob        2000      2.0      1000     2
Charlie    2000      2.0      1000     2
```

Alice deserves 2x Bob & Charlie

Alice: 4

Bob: 2

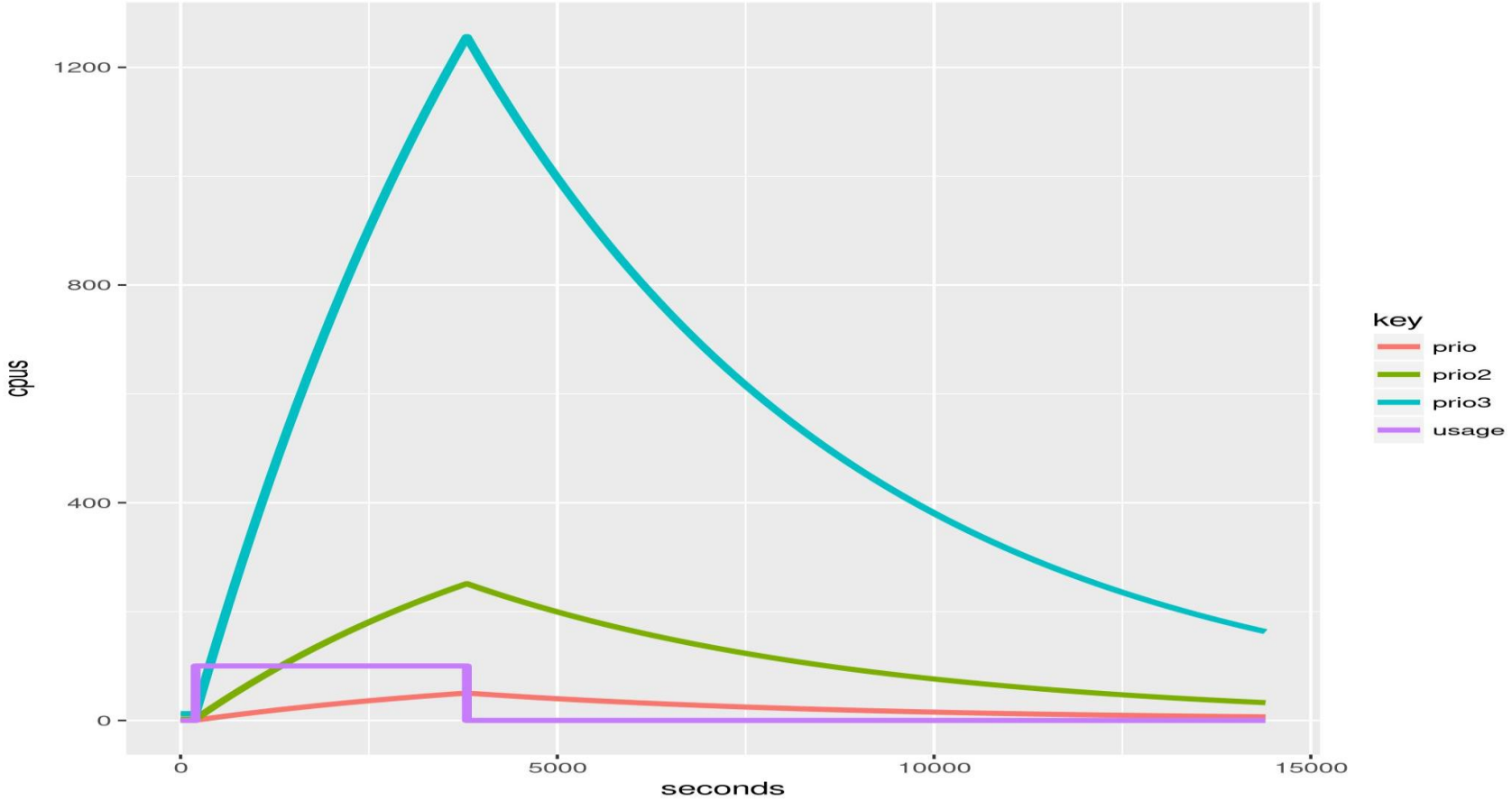
Charlie: 2 (Assuming 8 total slots)

```
UserName Effective Real      Priority  Res
         Priority Priority   Factor  in use
Alice      1000      1.0      1000      4
Bob        2000      2.0      1000      2
Charlie    2000      2.0      1000      2
```

Priority factor lets admin say
If equal usage, User A gets 1/nth User B

```
$ condor_userprio –setfactor alice 5000
```

3 different PrioFactors



Whew! Back to negotiation

1. Get all slots in the pool
2. Get all ~~jobs~~ submitters in pool
3. Compute # of slots submitters should get
4. In priority order, hand out slots to submitters
5. Repeat as needed

Target allocation from before

User	Effective Priority	Goal
Alice	1,000.00	4
Bob	2,000.00	2
Charlie	2,000.00	2

Assume 8 total slots (claimed or not)

Look at current usage

User	Effective Priority	Goal	Current Usage
Alice	1,000.00	4	3
Bob	2,000.00	2	1
Charlie	2,000.00	2	0

Diff the goal and reality

User	Effective Priority	Goal	Current Usage	Difference (“Limit”)
Alice	1,000.00	4	3	1
Bob	2,000.00	2	1	1
Charlie	2,000.00	2	0	2

“Submitter Limit” per user

User	Effective Priority	Goal	Current Usage	Difference (“Limit”)
Alice	1,000.00	4	3	**1**
Bob	2,000.00	2	1	**1**
Charlie	2,000.00	2	0	**2**

Limits determined, matchmaking starts

In Effective User Priority order,

Find a schedd for that user, get the request

User	Effective Priority	Difference (“Limit”)
Alice	1,000.00	**1**
Bob	2,000.00	**1**
Charlie	2,000.00	**2**

“Requests”, not “jobs”

```
$ condor_q -autocluster Alice
Id      Count Cpus Memory Requirements
20701      10    1   2000  OpSys == “Linux”
20702      20    2   1000  OpSys == “Windows”
```

Match *all* machines to requests

```
Id      Count Cpus Memory Requirements
20701      10    1   2000  OpSys == "Linux"
```

```
slot1@... Linux   X86_64 Idle    2048
slot2@... Linux   X86_64 Idle    2048
slot1@... Linux   X86_64 Idle    1024
slot2@... Linux   X86_64 Claimed 2048
slot1@... WINDOWS X86_64 Claimed 1024
```

Sort All matches

By 3 keys, in order

```
NEGOTIATOR_PRE_JOB_RANK
RANK
NEGOTIATOR_POST_JOB_RANK
```

Why Three?

`NEGOTIATOR_PRE_JOB_RANK`

Strongest, goes first over job RANK

`RANK`

Allows User some say

`NEGOTIATOR_POST_JOB_RANK`

Fallback default

Finally, give matches away!

```
slot1@... Linux   X86_64 Unclaimed 2048
slot2@... Linux   X86_64 Unclaimed 2048
slot1@... Linux   X86_64 Claimed   2048
```

Up to the limit specified earlier

If below limit, ask for next job request

Done with Alice, on to Bob

User	Effective Priority	Difference (“Limit”)
Alice	1,000.00	**1**
Bob	2,000.00	**1**
Charlie	2,000.00	**2**

But, it isn't that simple…

- Assumed every job matches every slot

  And infinite supply of jobs!

- … But what if they don't match?

  There will be leftovers – then what?

Lather, rinse, repeat

This whole cycle repeats with leftover slots

Again in same order…

Big policy question

- Preemption: Yes or no?
- Tradeoff: fairness vs. throughput
- (default: no preemption)

Preemption: disabled by default

```
PREEMPTION_REQUIREMENTS = false
```

Evaluated with slot & request ad. If true,
Claimed slot is considered matched, and
Subject to matching

Example PREEMPTION_REQs

```
PREEMPTION_REQUIREMENTS=\
 RemoteUserPrio > SubmittorPrio * 1.2
```

PREEMPTION_RANK

- Sorts matched preempting claims

```
PREEMPTION_RANK = -TotalJobRunTime
```

MaxJobRetirementTime

- Can be used to guarantee minimum time
- E.g. if claimed, give an hour runtime, no matter what:

- MaxJobRetirementTime = 3600
- Can also be an expression

Whew!

- Now, on to Groups.

First AccountingGroup

- AccountingGroup as alias
- Accounting_Group_User = Ishmael
- “**Call me Ishmael**”
- With no dots, and no other configuration
- Means alias: Maps “user” to “submitter”
- Complete trust in user job ad (or xform)
  - Viz-a-vis SUBMIT_REQUIREMENTs

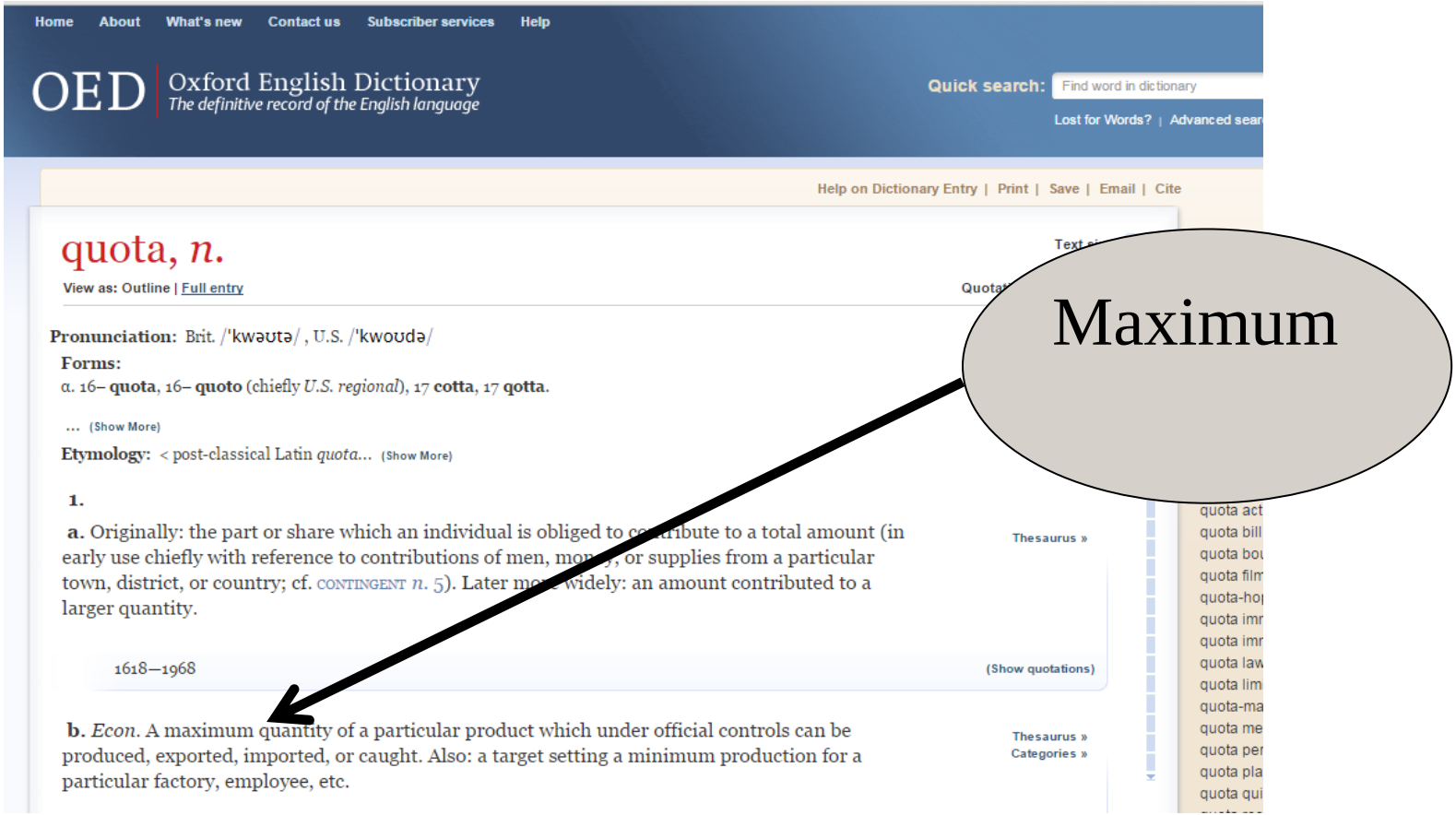
User	Effective Priority	Accounting Group
Alice	1,000.00	“Alice”
Bob	2,000.00	“Alice”
Charlie	2,000.00	

Merged to one user

No fair share between old Alice and old Bob!

Accounting Groups With Quota

Only way to get “quotas” for users or groups


Home
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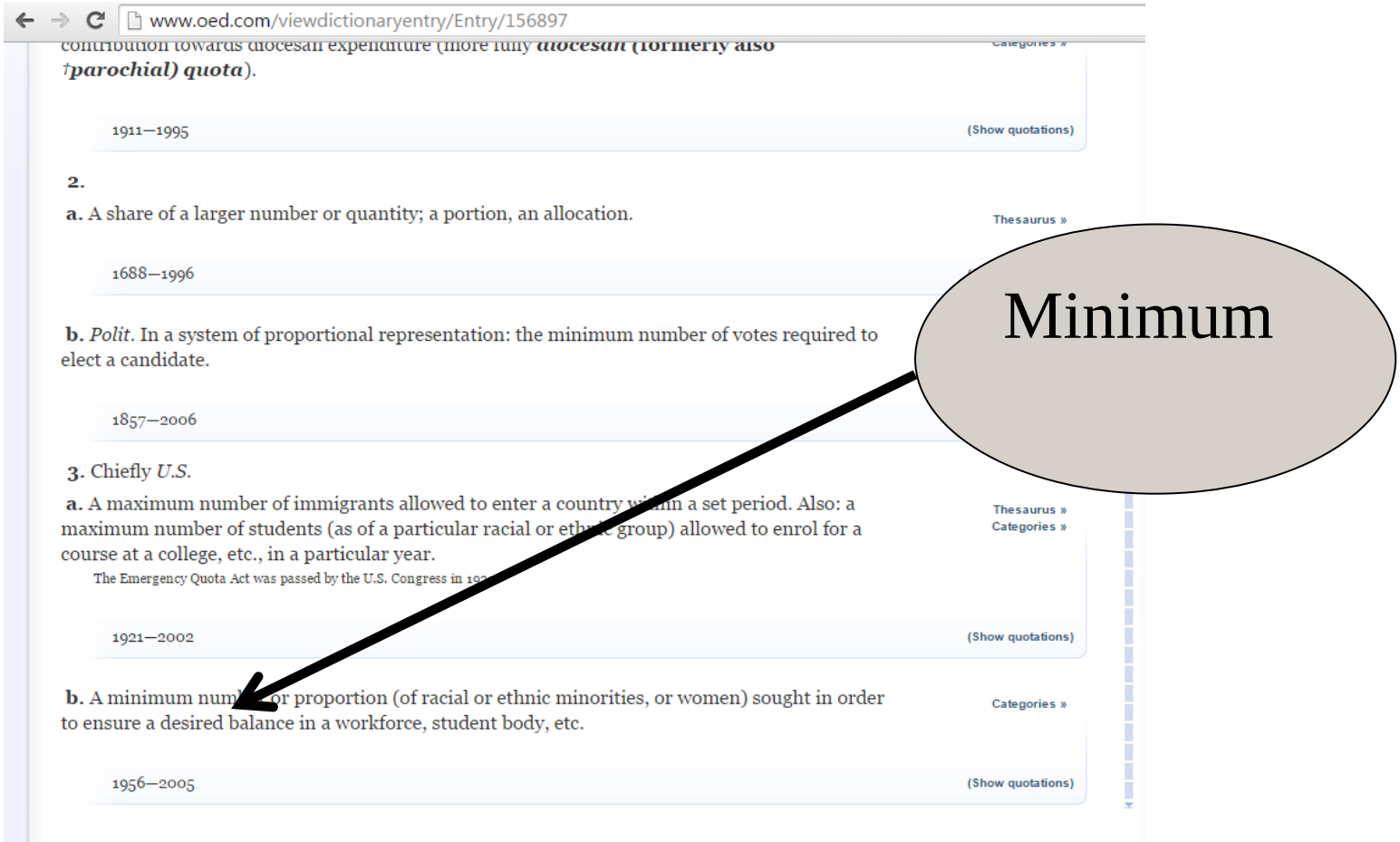
OED
Oxford English Dictionary
The definitive record of the English language
Quick search:
Find word in dictionary
Lost for Words?
Help on Dictionary Entry | Print | Save | Email | Cite
quota, n.
View as: Outline | Full entry
Pronunciation: Brit. /ˈkwəʊtə/ , U.S. /ˈkwoʊdə/
Forms:
α. 16– quota, 16– quoto (chiefly U.S. regional), 17 cotta, 17 qotta.
... (Show More)
Etymology: < post-classical Latin quota... (Show More)
1.
a. Originally: the part or share which an individual is obliged to contribute to a total amount (in early use chiefly with reference to contributions of men, money, or supplies from a particular town, district, or country; cf. CONTINGENT n. 5). Later more widely: an amount contributed to a larger quantity.
Thesaurus »
1618—1968
(Show quotations)
b. Econ. A maximum quantity of a particular product which under official controls can be produced, exported, imported, or caught. Also: a target setting a minimum production for a particular factory, employee, etc.
Thesaurus »
Categories »
Maximum


www.oed.com/viewdictionaryentry/Entry/156897
contribution towards diocesan expenditure (more fully diocesan (formerly also †parochial) quota).
1911–1995
(Show quotations)
2.
a. A share of a larger number or quantity; a portion, an allocation.
Thesaurus »
1688–1996
b. Polit. In a system of proportional representation: the minimum number of votes required to elect a candidate.
1857–2006
3. Chiefly U.S.
a. A maximum number of immigrants allowed to enter a country within a set period. Also: a maximum number of students (as of a particular racial or ethnic group) allowed to enrol for a course at a college, etc., in a particular year.
Thesaurus »
Categories »
The Emergency Quota Act was passed by the U.S. Congress in 192
1921–2002
(Show quotations)
b. A minimum number or proportion (of racial or ethnic minorities, or women) sought in order to ensure a desired balance in a workforce, student body, etc.
Categories »
1956–2005
(Show quotations)
Minimum

Accounting Groups with quotas

- Must be predefined in config file

```
GROUP_NAMES = group_a, group_b
GROUP_QUOTA_GROUP_A = 10
GROUP_QUOTA_GROUP_B = 20
```

Slot weight is the unit – default cpus

Or, with Dynamic quotas

- Can also be a percentage

```
GROUP_NAMES = group_a, group_b
GROUP_QUOTA_GROUP_A = 0.3
GROUP_QUOTA_GROUP_B = 0.4
```

If sum != 100, scaled

And jobs opt in (again)

```
Accounting_Group          = group_a
```

But you retain identity within your group.

AcctGroups w/quota

- Reruns the whole cycle as before
  - But with pool size constrained to quota
  - And fair share, between users in group

Order of groups?

- By default, in starvation order
- Creates overprovisioning trick for strict fifo:
  - `GROUP_QUOTA_HIPRIO = 100000000`
- Means this group always most starving
  - `GROUP_SORT_EXPR` overrides

“Not” strict quotas

One way is:

```
GROUP_AUTO_REGROUP = true
```

After all groups go, one last round with no groups, every user outside of their group.

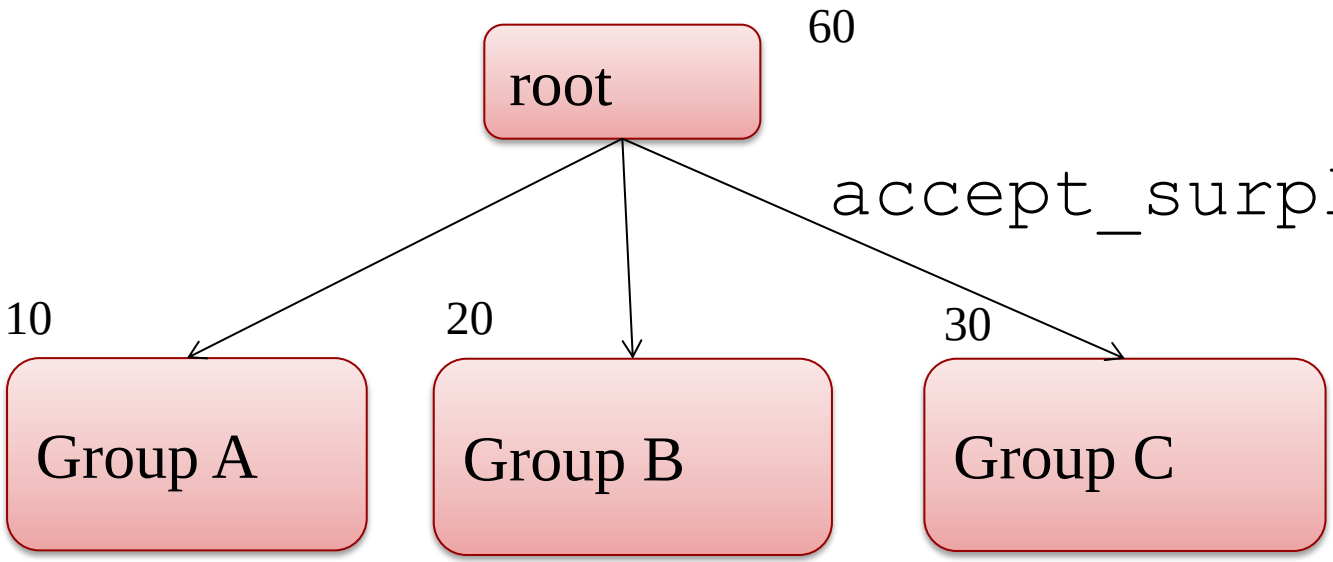
2nd not strict quota

- “Surplus”
- Assumes a hierarchy of groups:

```
GROUP_NAMES = group_root, group_root.a, group_root.b,
group_root.c
GROUP_QUOTA_GROUP_root = 60
GROUP_QUOTA_GROUP_root.a = 10
GROUP_QUOTA_GROUP_root.b = 20
GROUP_QUOTA_GROUP_root.b = 30
GROUP_ACCEPT_SURPLUS = true
```

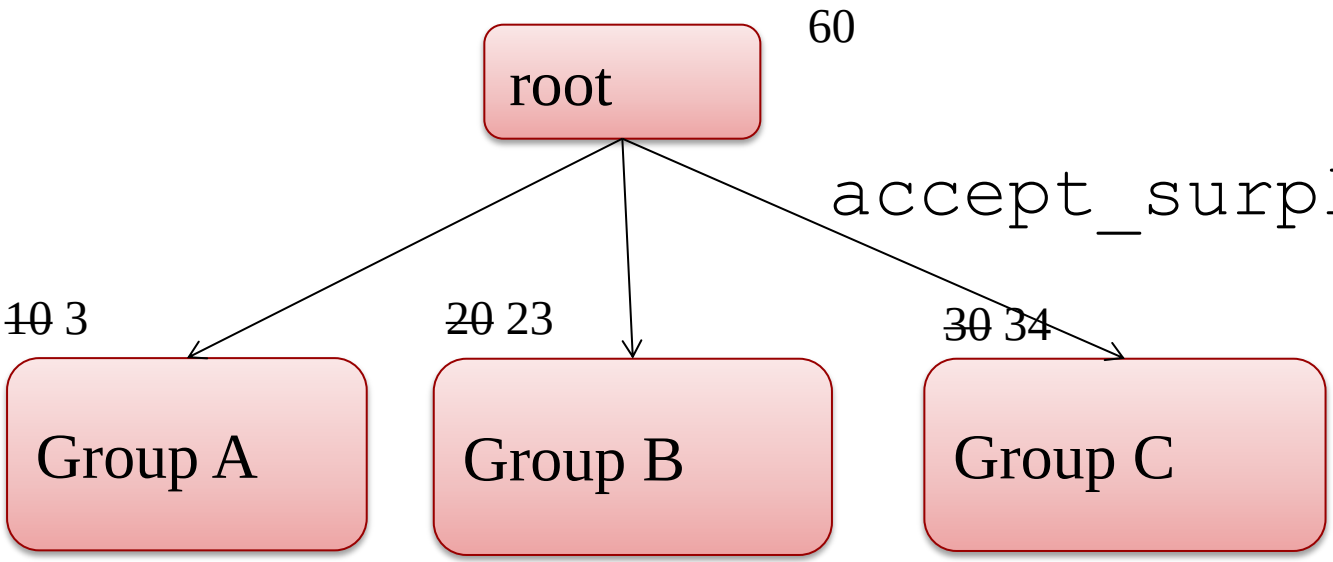
How “Surplus” works

- Before **matchmaking**
- Assume all jobs match all slots,
  - See if there will be leftover slots
  - If so, “loan” leftover slots to nearest group that accepts surplus



3 slots of demand at A → 7 quota slots moved to B & C

Proportional to B & C quota


60
root
accept_surplus = true
~~10~~ 3
~~20~~ 23
~~30~~ 34
Group A
Group B
Group C

Gotchas with quotas

- Quotas don’t know about matching
- Assuming everything matches everything
- Surprises with partitionable slots
- Managing groups not easy

In summary

- Negotiator is very powerful, often ignored
- Lots of opportunity to tune system
- Many ways to peak under the hood

Thank you

- Questions?
- Talk to us
- htcondor-users
- manual