New Read Balancer in Ceph

Ceph Virtual 2022

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Motivation

- In a distributed storage system like Ceph, it is important to balance write and read requests across OSDs for optimal performance.
- The existing capacity balancer works well to balance write requests, but there is still a need to balance read requests, especially in small clusters and pools with less PGs.
- In order to improve the Ceph balancing process, we established three goals:
    1. Collect osdmaps from the Ceph community, particularly from small clusters, for better testing
    2. Refactor the existing balancer code (calc_pg_upmaps) to make it easier for Ceph developers to understand the code and contribute
    3. Implement a workload balancer to balance read requests on a pool-by-pool basis

Capacity Balancer

- A Functional requirement
  - A cluster is as full as the fullest device
  - Therefore it is a strict requirement
- Balancing is expensive
  - It takes time, and during this time the performance of the system is reduced.
  - It requires data movement (by definition)
- It balances the write performance …
  - … if all devices are homogenous (same size and performance)

Read Balancer (a.k.a Primary Balancer)

- A Performance requirement
  - Unbalanced reads reduce the cluster overall bandwidth (due to weakest link in the chain effect)
- Balancing is cheap
  - It is just a metadata operation, fast and involve no data movement
  - No impact on the cluster performance (except improved performance when the operation completes (almost immediately))
- It balances the read performance …
  - … if all devices are homogenous (same size and performance)
- BUT - in future versions
  - The same mechanism can be used to improve overall cluster performance in heterogeneous systems
  - The same mechanism can be used to compensate on node performance fluctuations

Current Situation

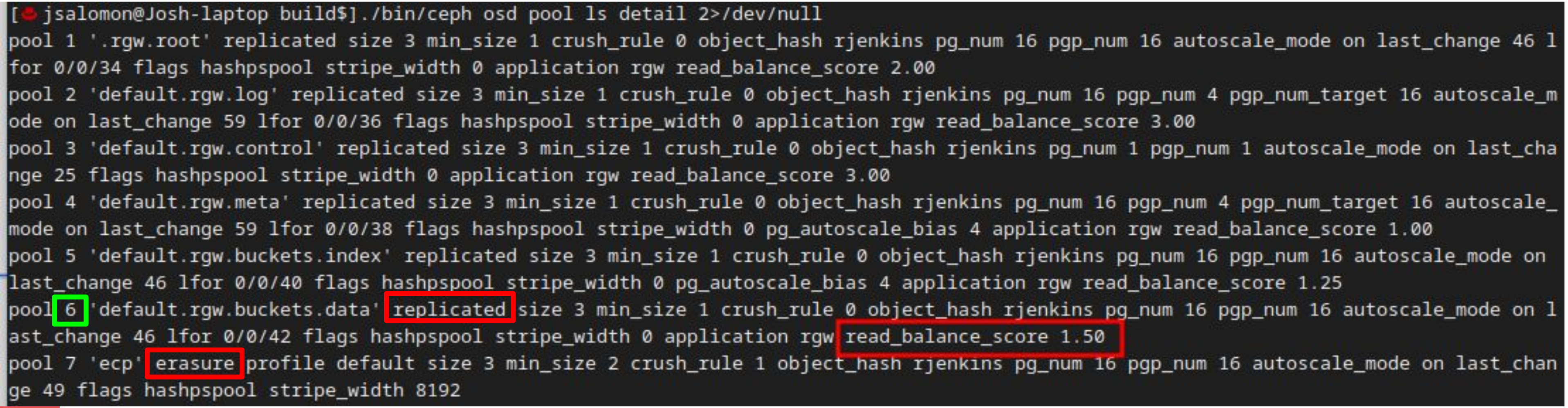
- Crush primary balancing (on homogeneous systems):
  - No active balancing code
  - Crush random distribution improves with larger PGs number
  - In general larger systems are quite balanced, smaller system may not be balanced
  - Most ODF instances are small, homogenous clusters.
- On heterogeneous systems:
  - Smaller devices get smaller loads (may fit some EBS pricing schemes, but not HDDs or SSDs)
  - Larger systems tend to become heterogenous over time
- Conclusion:
  - Read balancer (the Reef feature) is useful mostly for ODF clusters
  - Workload Balancer (planned for future versions, will be based on the read balancer infrastructure) will be useful for large, heterogeneous clusters

Stepping Stones 1/2

Read balancer score:

Added additional item to the output of the command: **`ceph osd pool ls detail`**

(applicable only for replicated pool)



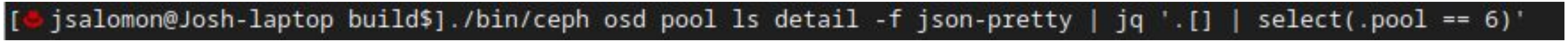
```
[ jsalomon@Josh-laptop build$]./bin/ceph osd pool ls detail 2>/dev/null
pool 1 '.rgw.root' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on last_change 46 l
for 0/0/34 flags hashpspool stripe_width 0 application rgw read_balance_score 2.00
pool 2 'default.rgw.log' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 4 pgp_num_target 16 autoscale_m
ode on last_change 59 lfor 0/0/36 flags hashpspool stripe_width 0 application rgw read_balance_score 3.00
pool 3 'default.rgw.control' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 1 pgp_num 1 autoscale_mode on last_cha
nge 25 flags hashpspool stripe_width 0 application rgw read_balance_score 3.00
pool 4 'default.rgw.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 4 pgp_num_target 16 autoscale_
mode on last_change 59 lfor 0/0/38 flags hashpspool stripe_width 0 pg_autoscale_bias 4 application rgw read_balance_score 1.00
pool 5 'default.rgw.buckets.index' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on
last_change 46 lfor 0/0/40 flags hashpspool stripe_width 0 pg_autoscale_bias 4 application rgw read_balance_score 1.25
pool 6 'default.rgw.buckets.data' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on l
ast_change 46 lfor 0/0/42 flags hashpspool stripe_width 0 application rgw read_balance_score 1.50
pool 7 'ecp' erasure profile default size 3 min_size 2 crush_rule 1 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on last_chan
ge 49 flags hashpspool stripe_width 8192
```

Read Balance Score

The meaning of the read balance score:

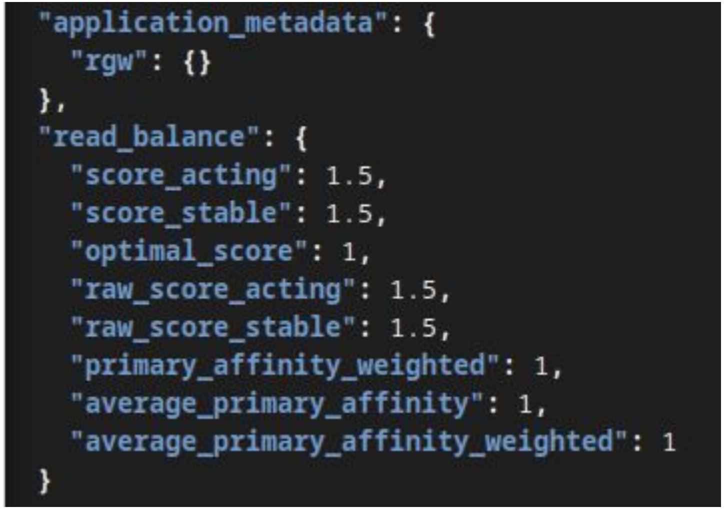
- Score of 1.0 is optimal
  - In most cases we can't achieve this score
  - When all primaries are in the same OSD the score is the replica count
- All scores in the range [1.0, replica_count]
- Score of 1 + x shows approximately (x*100)% degradation in pool read performance under load
  - Score of 1.2 is roughly 20% degradation.

Read Balance Score - more info I



```
[ jsalomon@Josh-laptop build$]./bin/ceph osd pool ls detail -f json-pretty | jq '.[] | select(.pool == 6)'
```

… skipped most of the json output here …



```
  "application_metadata": {
    "rgw": {}
  },
  "read_balance": {
    "score_acting": 1.5,
    "score_stable": 1.5,
    "optimal_score": 1,
    "raw_score_acting": 1.5,
    "raw_score_stable": 1.5,
    "primary_affinity_weighted": 1,
    "average_primary_affinity": 1,
    "average_primary_affinity_weighted": 1
  }
```

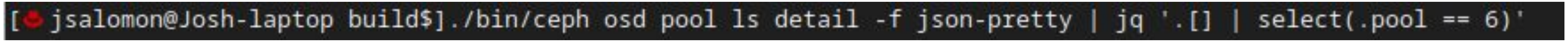
⇐ used to be the last object in the json/xml file

⇐ A new object with more information on read balance score
  ⇐ scores calculated on primaries as well as acting primaries
  ⇐ optimal score may change when we have devices with low primary affinity

  ⇐ We have information about the score calculation before and after adjustments to the primary affinity and its weights

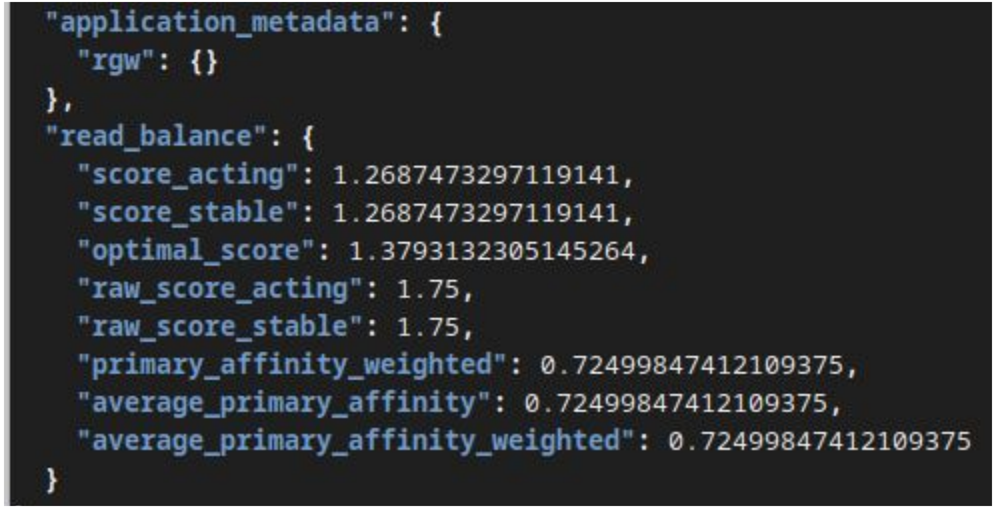
Read Balance Score - more info II

Reducing primary affinity of some OSDs



```
[ jsalomon@Josh-laptop build$]./bin/ceph osd pool ls detail -f json-pretty | jq '.[] | select(.pool == 6)'
```

… skipped most of the json output here …



```
  "application_metadata": {
    "rgw": {}
  },
  "read_balance": {
    "score_acting": 1.2687473297119141,
    "score_stable": 1.2687473297119141,
    "optimal_score": 1.3793132305145264,
    "raw_score_acting": 1.75,
    "raw_score_stable": 1.75,
    "primary_affinity_weighted": 0.72499847412109375,
    "average_primary_affinity": 0.72499847412109375,
    "average_primary_affinity_weighted": 0.72499847412109375
  }
```

Score = raw_score / optimal_score

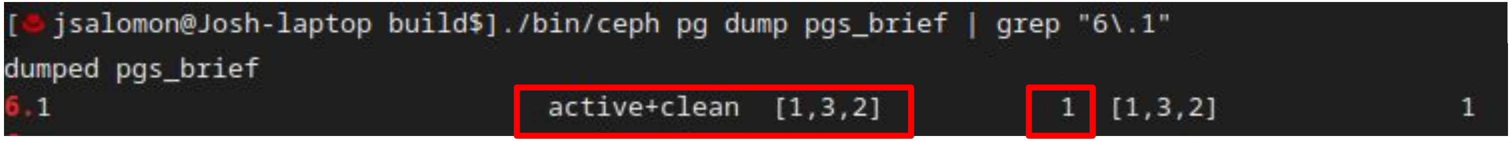
Weighted info takes into account the OSD sizes, in this case all OSDs are in the same size hence average_primary_affinity and average_primary_affinity_weighted are identical.

Stepping Stones 2/2

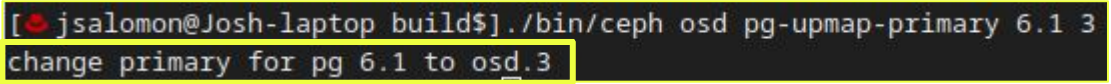
Added two commands to change the primary OSD for a PG in a replicated pool. The new primary must be one of the OSDs which participate in this PG.

- `ceph osd pg-upmap-primary <pgid> <osdid>`
- `ceph osd rm-pg-upmap-primary <pgid>`

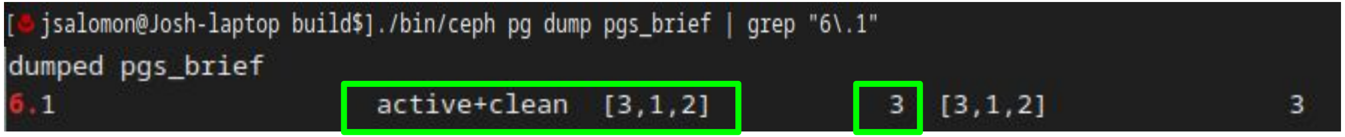
(These commands are applicable only for replicated pools.)



```
[ jsalomon@Josh-laptop build$]./bin/ceph pg dump pgs_brief | grep "6\.1"
dumped pgs_brief
6.1                          active+clean   [1,3,2]          1  [1,3,2]             1
```



```
[ jsalomon@Josh-laptop build$]./bin/ceph osd pg-upmap-primary 6.1 3
change primary for pg 6.1 to osd.3
```



```
[ jsalomon@Josh-laptop build$]./bin/ceph pg dump pgs_brief | grep "6\.1"
dumped pgs_brief
6.1                  active+clean   [3,1,2]          3  [3,1,2]             3
```

High Level Design

Two important functions make up the read balancer’s framework:

1. **OSDMap::calc_desired_primary_distribution**
    a. A policy function that can be changed
2. **OSDMap::balance_primaries**
    a. The overall balancing algorithm

A deeper dive into OSDMap::calc_desired_primary_distribution

What does this function do?

Overall, it **calculates the optimal amount of primary pgs** that should be on each OSD per pool. It does so by:

1. Checking that the pool we're balancing is **replicated**
2. Finding the **replica count** of the pool
3. Finding the **num_pgs** on each OSD
4. Calculating the **desired_primary_distrubution** for each OSD, which is:
   a. **desired_primary_distribution** = (**num_pgs** / **replica_count**) * **primary_affinity(OSD)**
5. Stretching the **desired_primary_distribution** for each OSD, so total distribution = the total number of pgs in the cluster. This applies mainly when primary affinity is smaller than 1.

A deeper dive into OSDMap::balance_primaries

What does this function do?

This is the function that actually **does the read balancing.** It does so by:

1. Using OSDMap::calc_desired_primary_distribution to find the **optimal primary distribution** for each OSD on the pool we want to balance
2. Calculating **how much each OSD deviates** from its optimal primary distribution
3. Based on the above deviations, **swapping PGs** so each OSD gets as close to its optimal primary distribution as possible
    i. This step ensures that primaries are only swapped between OSDs on the same PG so there is no data movement
4. Returning the **new pg mappings** and **total number of changes**

The future of these implementations

How might we enhance these functions in the future?

OSDMap::calc_desired_primary_distribution

1. The current implementation can be thought of as “phase 1”, since it assumes all devices are identical.
2. Future improvements may involve implementing a policy that puts more read load on smaller disks, which are known to have less write load.

OSDMap::balance_primaries

1. Aside from any optimizations, the basic structure of this function will not change.
2. It can be thought of as a base tree trunk that may grow more branches, or optimizations, in the future.

Live Demos

- **Demo 1:** Balance a cluster with devices of equal primary affinity
- **Demo 2:** Balance a cluster where one device has 0 primary affinity

*** Notes ***

- Since the new “pg-upmap-primary” commands are not merged yet, we use “primary-temp” command for this demo.
- Screenshots of this demo are available at the end of the presentation.

Future Plans and Improvements

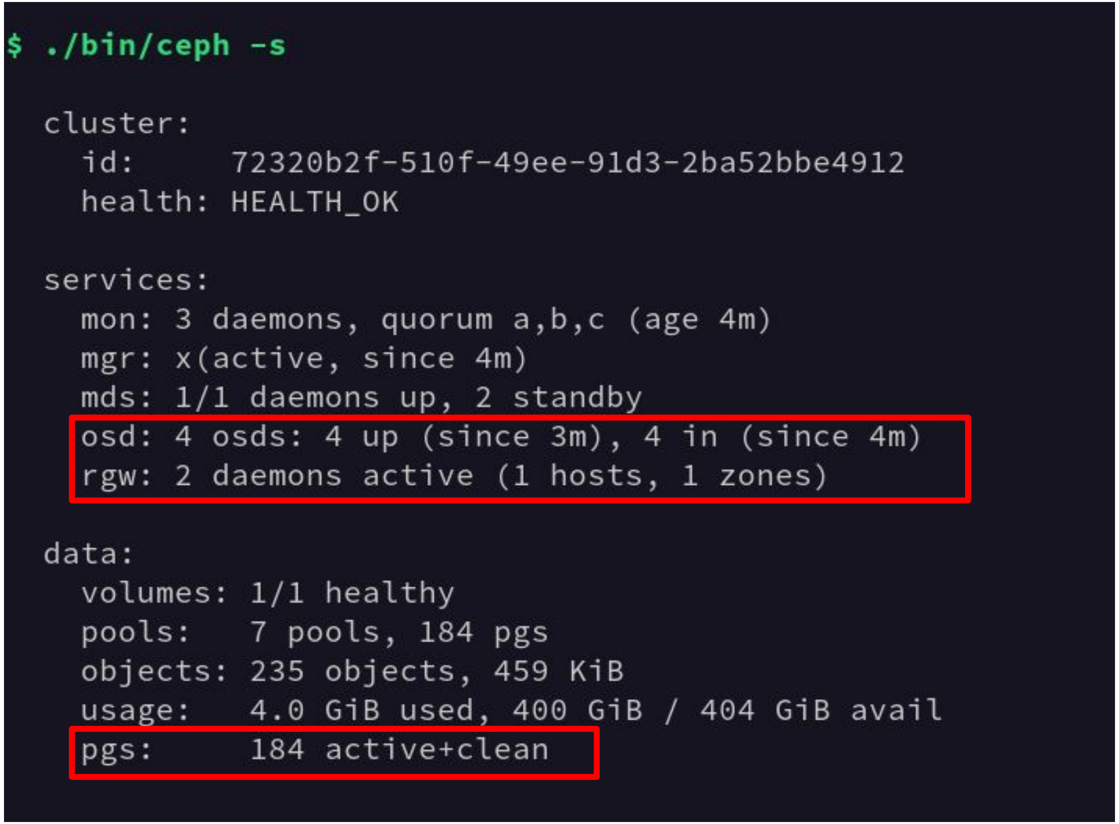
- Conduct performance tests
- Add read balancer integration tests to the teuthology rados suite
- Turn the read balancer on by default as part of the balancer manager module
- Account for devices of different sizes

Questions

Demo 1:
Balance a cluster with devices of equal primary affinity

Demo 1

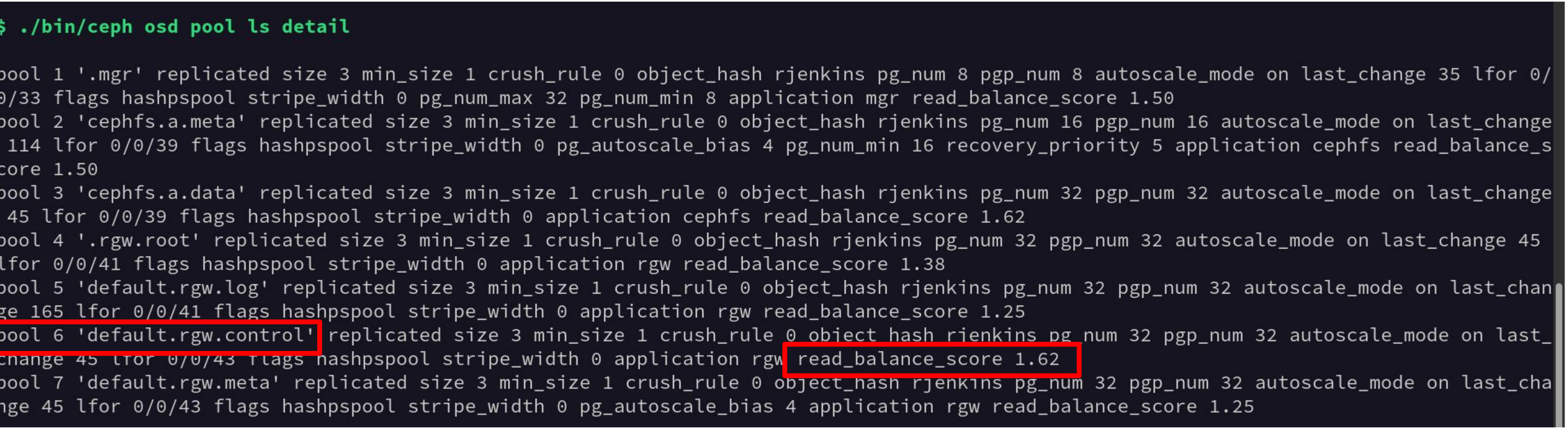
Check ceph status



```
$ ./bin/ceph -s

  cluster:
    id:     72320b2f-510f-49ee-91d3-2ba52bbe4912
    health: HEALTH_OK

  services:
    mon: 3 daemons, quorum a,b,c (age 4m)
    mgr: x(active, since 4m)
    mds: 1/1 daemons up, 2 standby
    osd: 4 osds: 4 up (since 3m), 4 in (since 4m)
    rgw: 2 daemons active (1 hosts, 1 zones)

  data:
    volumes: 1/1 healthy
    pools:   7 pools, 184 pgs
    objects: 235 objects, 459 KiB
    usage:   4.0 GiB used, 400 GiB / 404 GiB avail
    pgs:     184 active+clean
```

Demo 1

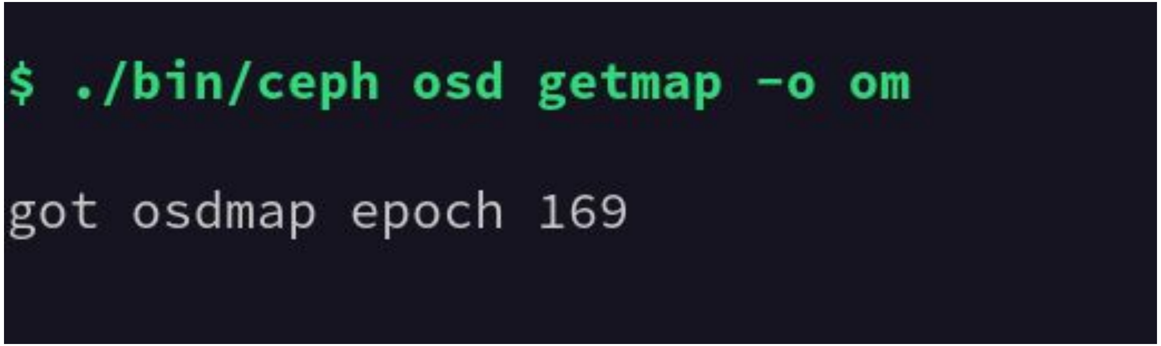
Check pool details for current read balancer scores. We'll try to improve the score of pool 6, or "default.rgw.control":



```
$ ./bin/ceph osd pool ls detail

pool 1 '.mgr' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 8 pgp_num 8 autoscale_mode on last_change 35 lfor 0/
0/33 flags hashpspool stripe_width 0 pg_num_max 32 pg_num_min 8 application mgr read_balance_score 1.50
pool 2 'cephfs.a.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on last_change
 114 lfor 0/0/39 flags hashpspool stripe_width 0 pg_autoscale_bias 4 pg_num_min 16 recovery_priority 5 application cephfs read_balance_s
core 1.50
pool 3 'cephfs.a.data' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change
 45 lfor 0/0/39 flags hashpspool stripe_width 0 application cephfs read_balance_score 1.62
pool 4 '.rgw.root' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change 45
lfor 0/0/41 flags hashpspool stripe_width 0 application rgw read_balance_score 1.38
pool 5 'default.rgw.log' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_chan
ge 165 lfor 0/0/41 flags hashpspool stripe_width 0 application rgw read_balance_score 1.25
pool 6 'default.rgw.control' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_
change 45 lfor 0/0/43 flags hashpspool stripe_width 0 application rgw read_balance_score 1.62
pool 7 'default.rgw.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_cha
nge 45 lfor 0/0/43 flags hashpspool stripe_width 0 pg_autoscale_bias 4 application rgw read_balance_score 1.25
```

Demo 1

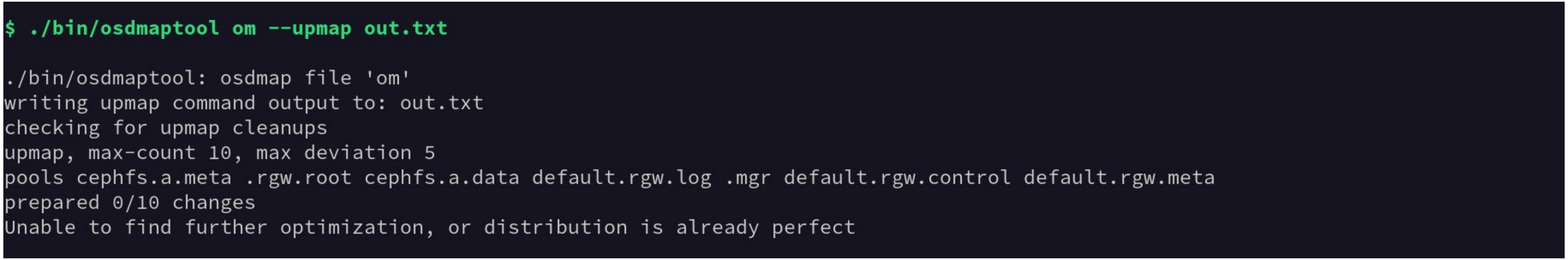
Get latest copy of your OSD map



```
$ ./bin/ceph osd getmap -o om

got osdmap epoch 169
```

Demo 1

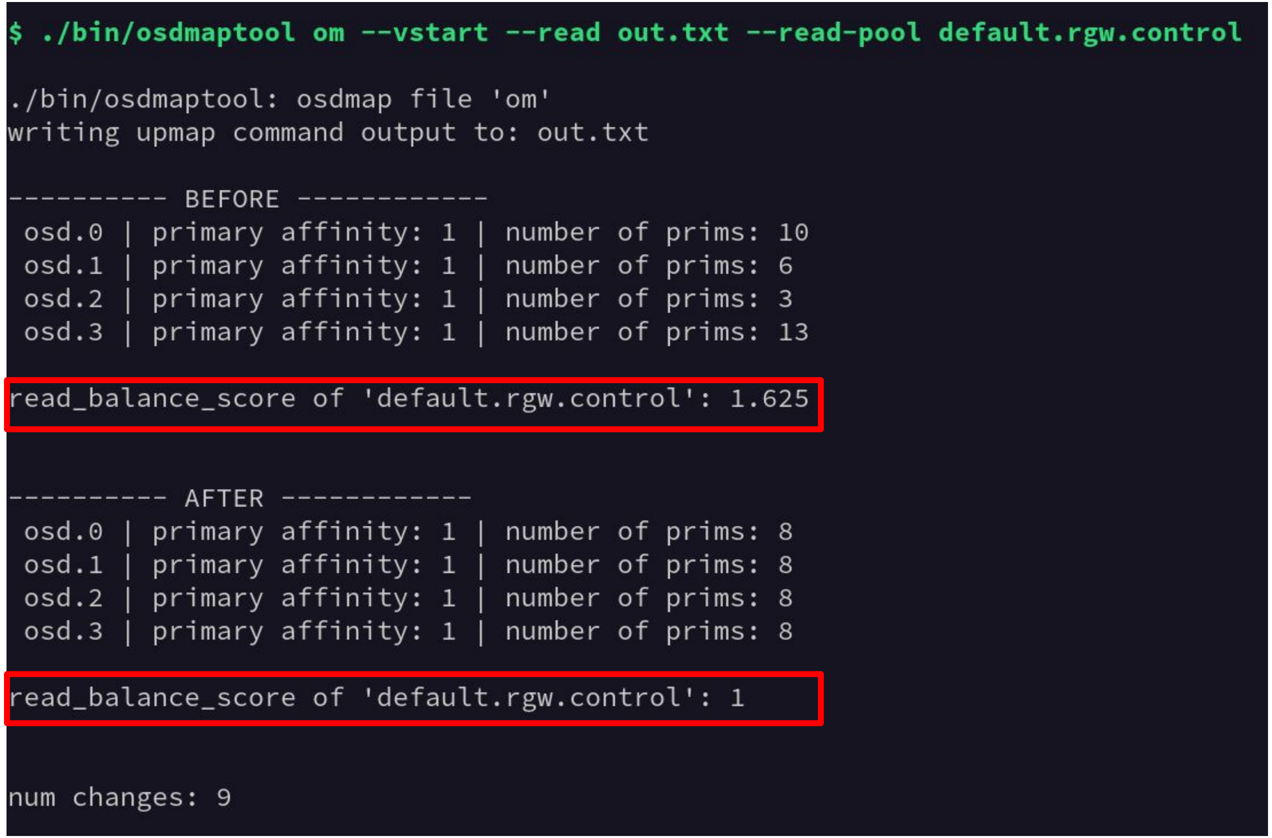
Run the upmap balancer first to make sure writes are balanced. In this case, the upmap balancer was unable to optimize further.



```
$ ./bin/osdmaptool om --upmap out.txt

./bin/osdmaptool: osdmap file 'om'
writing upmap command output to: out.txt
checking for upmap cleanups
upmap, max-count 10, max deviation 5
pools cephfs.a.meta .rgw.root cephfs.a.data default.rgw.log .mgr default.rgw.control default.rgw.meta
prepared 0/10 changes
Unable to find further optimization, or distribution is already perfect
```

Demo 1

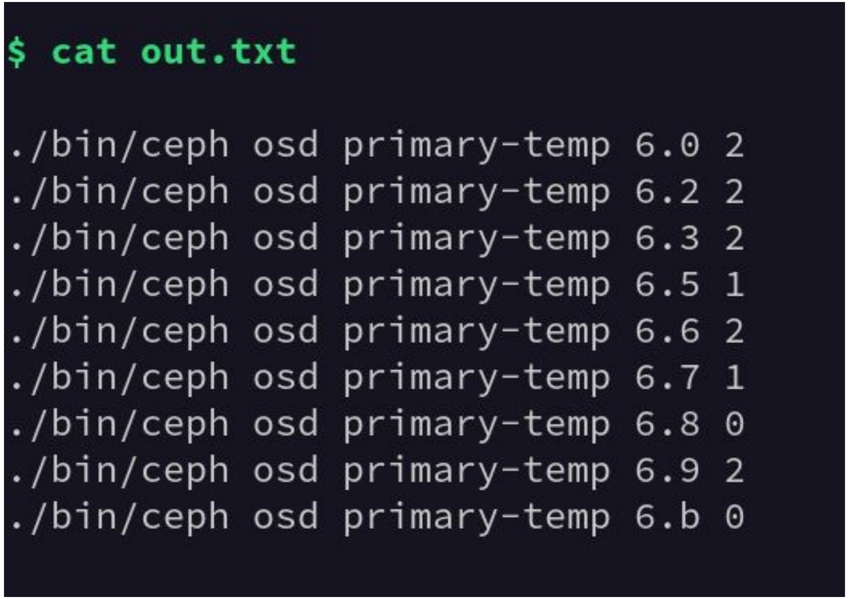
Run the read balancer, focusing on "default.rgw.control".



```
$ ./bin/osdmaptool om --vstart --read out.txt --read-pool default.rgw.control

./bin/osdmaptool: osdmap file 'om'
writing upmap command output to: out.txt

---------- BEFORE ------------
 osd.0 | primary affinity: 1 | number of prims: 10
 osd.1 | primary affinity: 1 | number of prims: 6
 osd.2 | primary affinity: 1 | number of prims: 3
 osd.3 | primary affinity: 1 | number of prims: 13

read_balance_score of 'default.rgw.control': 1.625


---------- AFTER ------------
 osd.0 | primary affinity: 1 | number of prims: 8
 osd.1 | primary affinity: 1 | number of prims: 8
 osd.2 | primary affinity: 1 | number of prims: 8
 osd.3 | primary affinity: 1 | number of prims: 8

read_balance_score of 'default.rgw.control': 1


num changes: 9
```

Demo 1

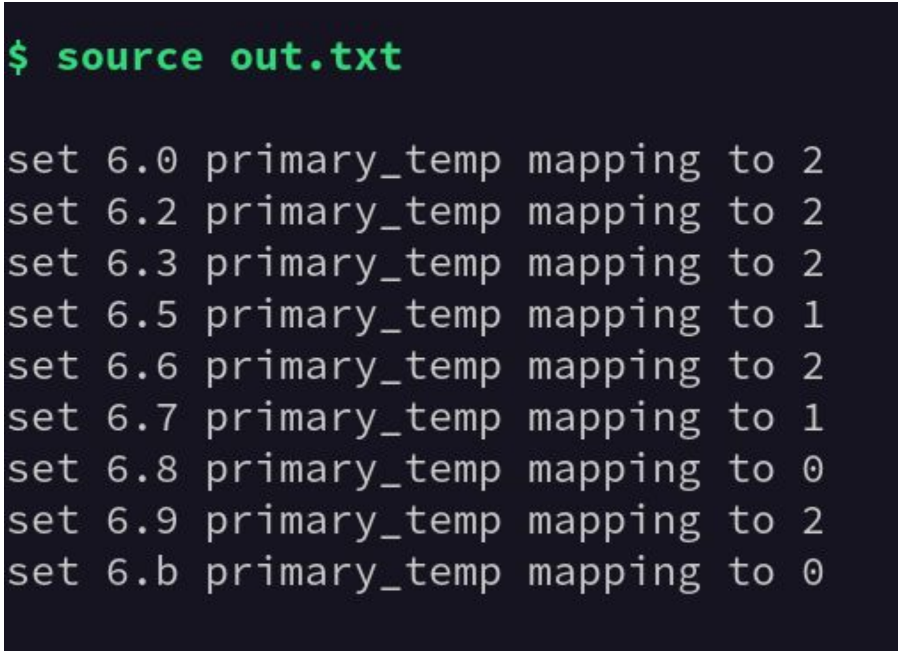
We can check to see what the balancer suggests in the “out.txt” file:



```
$ cat out.txt

./bin/ceph osd primary-temp 6.0 2
./bin/ceph osd primary-temp 6.2 2
./bin/ceph osd primary-temp 6.3 2
./bin/ceph osd primary-temp 6.5 1
./bin/ceph osd primary-temp 6.6 2
./bin/ceph osd primary-temp 6.7 1
./bin/ceph osd primary-temp 6.8 0
./bin/ceph osd primary-temp 6.9 2
./bin/ceph osd primary-temp 6.b 0
```

Demo 1

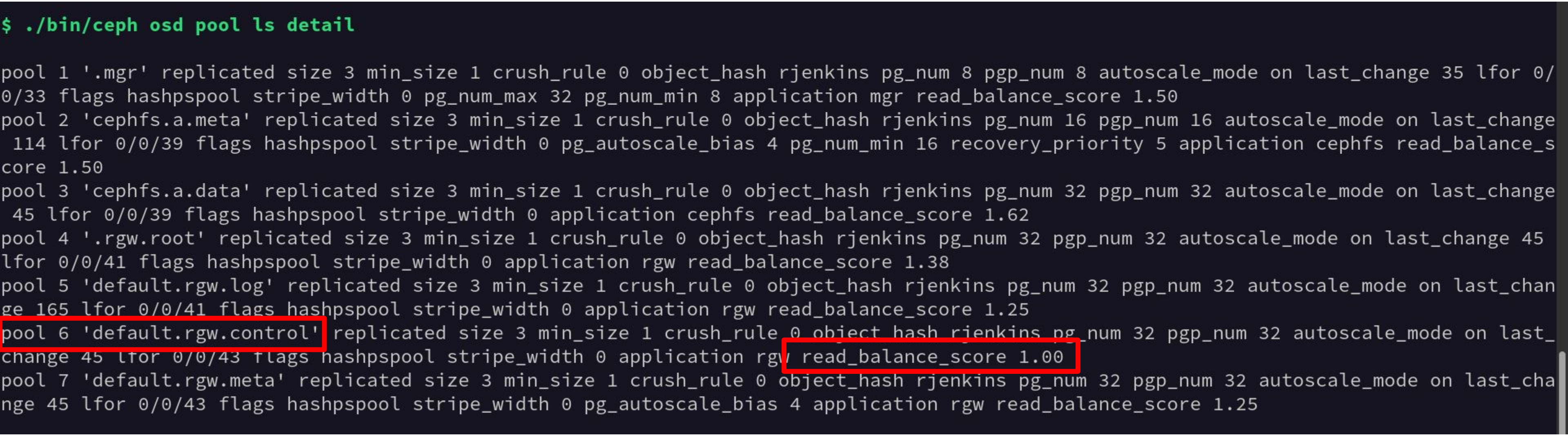
We can apply the file to a live system if we choose:



```
$ source out.txt

set 6.0 primary_temp mapping to 2
set 6.2 primary_temp mapping to 2
set 6.3 primary_temp mapping to 2
set 6.5 primary_temp mapping to 1
set 6.6 primary_temp mapping to 2
set 6.7 primary_temp mapping to 1
set 6.8 primary_temp mapping to 0
set 6.9 primary_temp mapping to 2
set 6.b primary_temp mapping to 0
```

Demo 1

Notice how the score has improved to 1.00 for “default.rgw.control”, which previously had a score of 1.62:

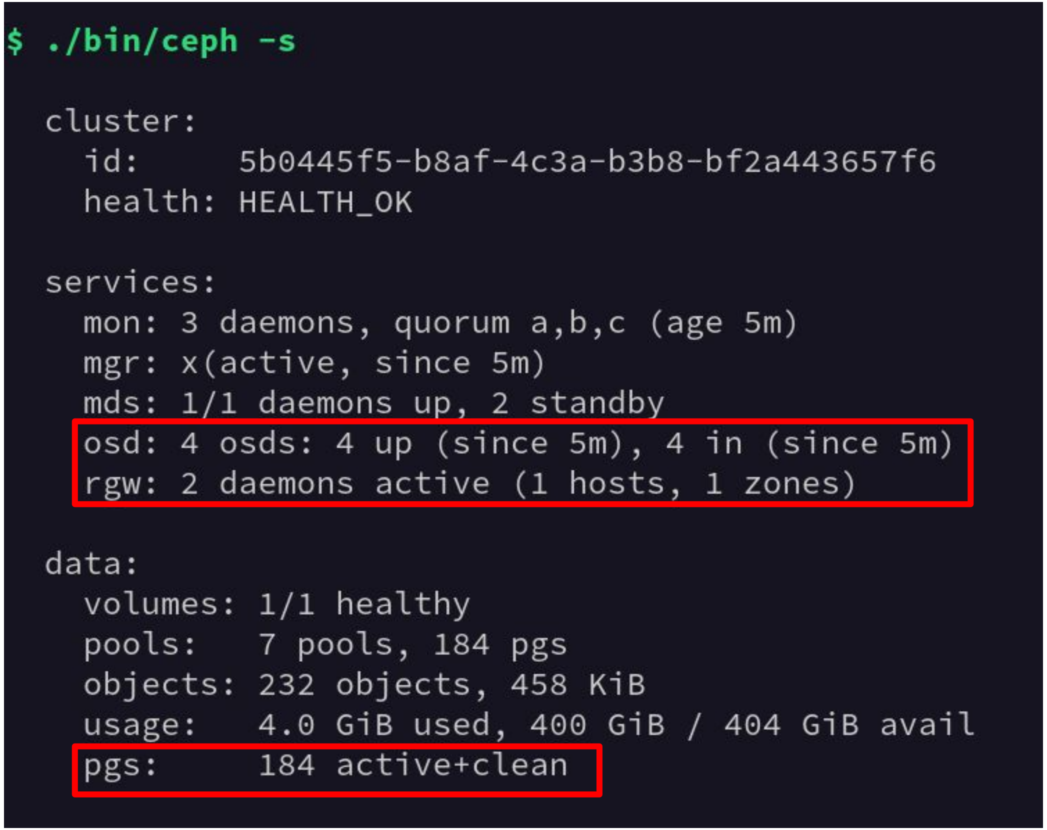


```
$ ./bin/ceph osd pool ls detail

pool 1 '.mgr' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 8 pgp_num 8 autoscale_mode on last_change 35 lfor 0/
0/33 flags hashpspool stripe_width 0 pg_num_max 32 pg_num_min 8 application mgr read_balance_score 1.50
pool 2 'cephfs.a.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on last_change
 114 lfor 0/0/39 flags hashpspool stripe_width 0 pg_autoscale_bias 4 pg_num_min 16 recovery_priority 5 application cephfs read_balance_s
core 1.50
pool 3 'cephfs.a.data' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change
 45 lfor 0/0/39 flags hashpspool stripe_width 0 application cephfs read_balance_score 1.62
pool 4 '.rgw.root' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change 45
lfor 0/0/41 flags hashpspool stripe_width 0 application rgw read_balance_score 1.38
pool 5 'default.rgw.log' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_chan
ge 165 lfor 0/0/41 flags hashpspool stripe_width 0 application rgw read_balance_score 1.25
pool 6 'default.rgw.control' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_
change 45 lfor 0/0/43 flags hashpspool stripe_width 0 application rgw read_balance_score 1.00
pool 7 'default.rgw.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_cha
nge 45 lfor 0/0/43 flags hashpspool stripe_width 0 pg_autoscale_bias 4 application rgw read_balance_score 1.25
```

Demo 2:
Balance a cluster where one device has 0 primary affinity

Demo 2

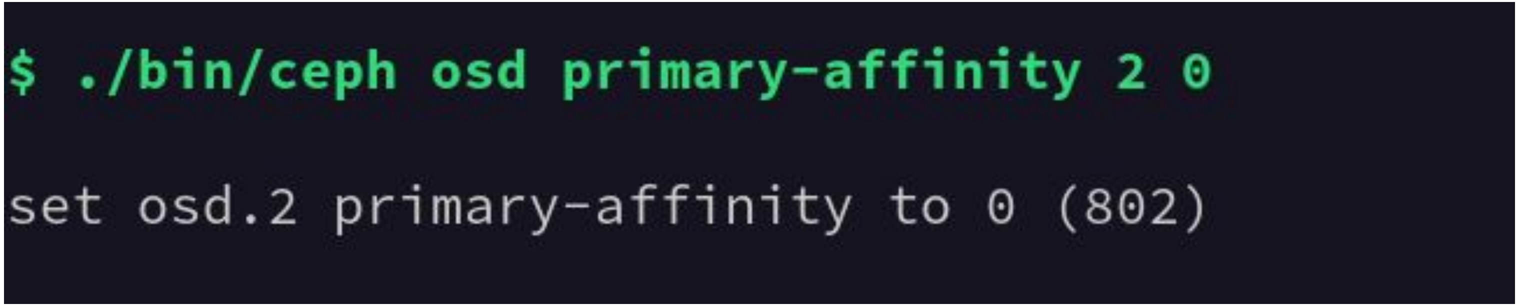
Check ceph status



```
$ ./bin/ceph -s

  cluster:
    id:     5b0445f5-b8af-4c3a-b3b8-bf2a443657f6
    health: HEALTH_OK

  services:
    mon: 3 daemons, quorum a,b,c (age 5m)
    mgr: x(active, since 5m)
    mds: 1/1 daemons up, 2 standby
    osd: 4 osds: 4 up (since 5m), 4 in (since 5m)
    rgw: 2 daemons active (1 hosts, 1 zones)

  data:
    volumes: 1/1 healthy
    pools:   7 pools, 184 pgs
    objects: 232 objects, 458 KiB
    usage:   4.0 GiB used, 400 GiB / 404 GiB avail
    pgs:     184 active+clean
```

Demo 2

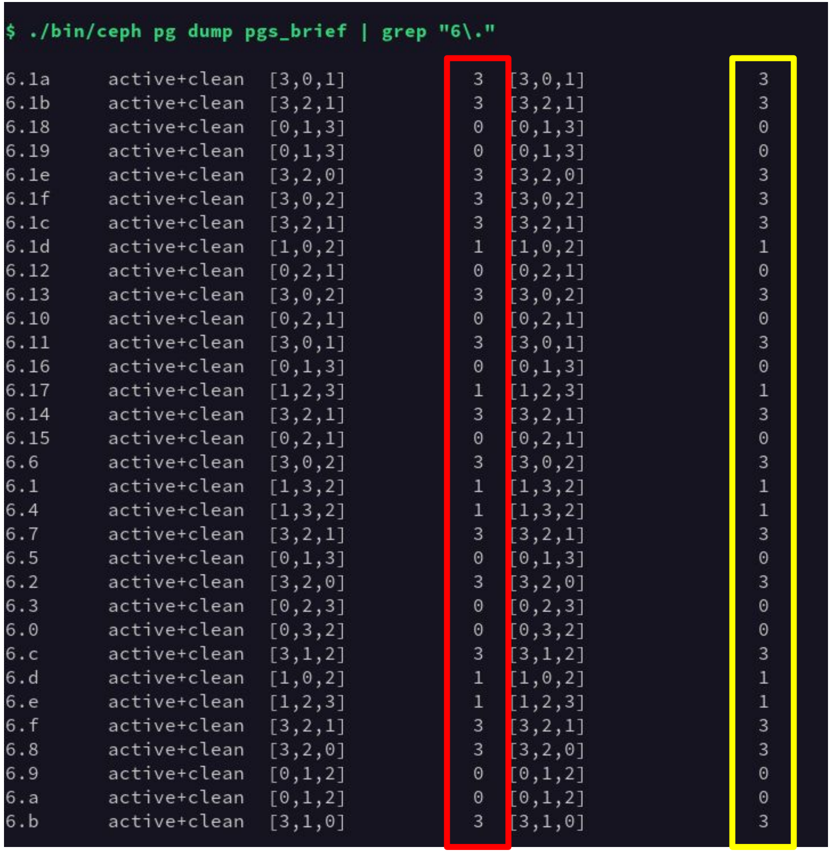
Change primary affinity on one of the OSDs.



```
$ ./bin/ceph osd primary-affinity 2 0
set osd.2 primary-affinity to 0 (802)
```

Demo 2

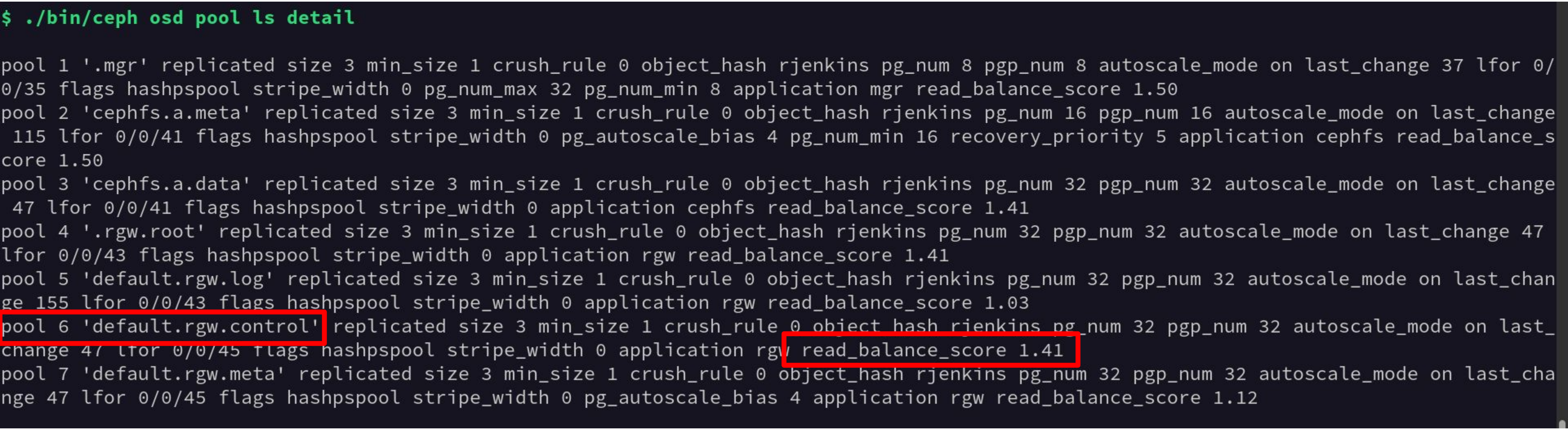
Check that no primary PGs are on osd.2.



```
$ ./bin/ceph pg dump pgs_brief | grep "6\."

6.1a     active+clean  [3,0,1]          3 [3,0,1]           3
6.1b     active+clean  [3,2,1]          3 [3,2,1]           3
6.18     active+clean  [0,1,3]          0 [0,1,3]           0
6.19     active+clean  [0,1,3]          0 [0,1,3]           0
6.1e     active+clean  [3,2,0]          3 [3,2,0]           3
6.1f     active+clean  [3,0,2]          3 [3,0,2]           3
6.1c     active+clean  [3,2,1]          3 [3,2,1]           3
6.1d     active+clean  [1,0,2]          1 [1,0,2]           1
6.12     active+clean  [0,2,1]          0 [0,2,1]           0
6.13     active+clean  [3,0,2]          3 [3,0,2]           3
6.10     active+clean  [0,2,1]          0 [0,2,1]           0
6.11     active+clean  [3,0,1]          3 [3,0,1]           3
6.16     active+clean  [0,1,3]          0 [0,1,3]           0
6.17     active+clean  [1,2,3]          1 [1,2,3]           1
6.14     active+clean  [3,2,1]          3 [3,2,1]           3
6.15     active+clean  [0,2,1]          0 [0,2,1]           0
6.6      active+clean  [3,0,2]          3 [3,0,2]           3
6.1      active+clean  [1,3,2]          1 [1,3,2]           1
6.4      active+clean  [1,3,2]          1 [1,3,2]           1
6.7      active+clean  [3,2,1]          3 [3,2,1]           3
6.5      active+clean  [0,1,3]          0 [0,1,3]           0
6.2      active+clean  [3,2,0]          3 [3,2,0]           3
6.3      active+clean  [0,2,3]          0 [0,2,3]           0
6.0      active+clean  [0,3,2]          0 [0,3,2]           0
6.c      active+clean  [3,1,2]          3 [3,1,2]           3
6.d      active+clean  [1,0,2]          1 [1,0,2]           1
6.e      active+clean  [1,2,3]          1 [1,2,3]           1
6.f      active+clean  [3,2,1]          3 [3,2,1]           3
6.8      active+clean  [3,2,0]          3 [3,2,0]           3
6.9      active+clean  [0,1,2]          0 [0,1,2]           0
6.a      active+clean  [0,1,2]          0 [0,1,2]           0
6.b      active+clean  [3,1,0]          3 [3,1,0]           3
```

Demo 2

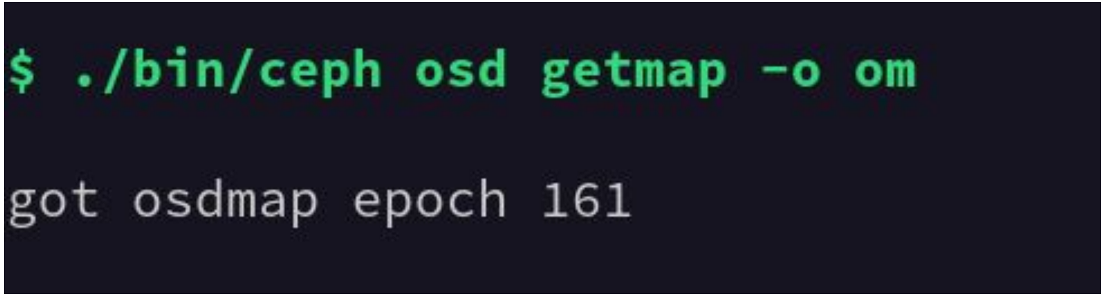
Check pool details for current read balancer scores. We'll try to improve the score of pool 6, or "default.rgw.control":



```
$ ./bin/ceph osd pool ls detail

pool 1 '.mgr' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 8 pgp_num 8 autoscale_mode on last_change 37 lfor 0/
0/35 flags hashpspool stripe_width 0 pg_num_max 32 pg_num_min 8 application mgr read_balance_score 1.50
pool 2 'cephfs.a.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on last_change
 115 lfor 0/0/41 flags hashpspool stripe_width 0 pg_autoscale_bias 4 pg_num_min 16 recovery_priority 5 application cephfs read_balance_s
core 1.50
pool 3 'cephfs.a.data' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change
 47 lfor 0/0/41 flags hashpspool stripe_width 0 application cephfs read_balance_score 1.41
pool 4 '.rgw.root' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change 47
lfor 0/0/43 flags hashpspool stripe_width 0 application rgw read_balance_score 1.41
pool 5 'default.rgw.log' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_chan
ge 155 lfor 0/0/43 flags hashpspool stripe_width 0 application rgw read_balance_score 1.03
pool 6 'default.rgw.control' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_
change 47 lfor 0/0/45 flags hashpspool stripe_width 0 application rgw read_balance_score 1.41
pool 7 'default.rgw.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_cha
nge 47 lfor 0/0/45 flags hashpspool stripe_width 0 pg_autoscale_bias 4 application rgw read_balance_score 1.12
```

Demo 2

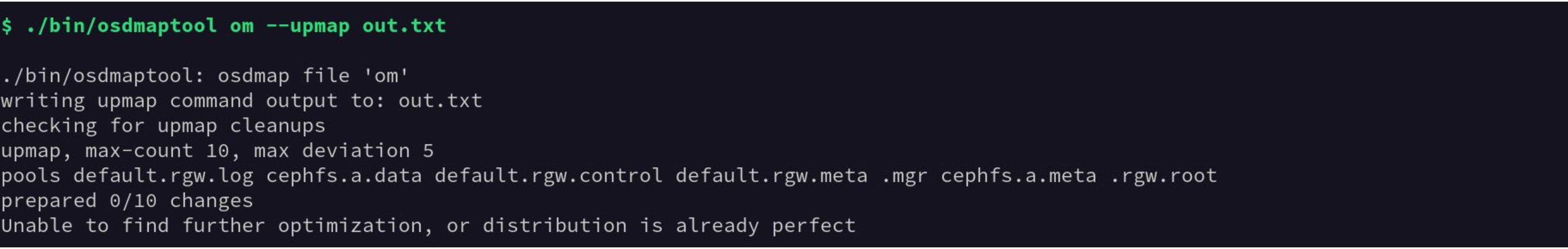
Get latest copy of your OSD map.



```
$ ./bin/ceph osd getmap -o om

got osdmap epoch 161
```

Demo 2

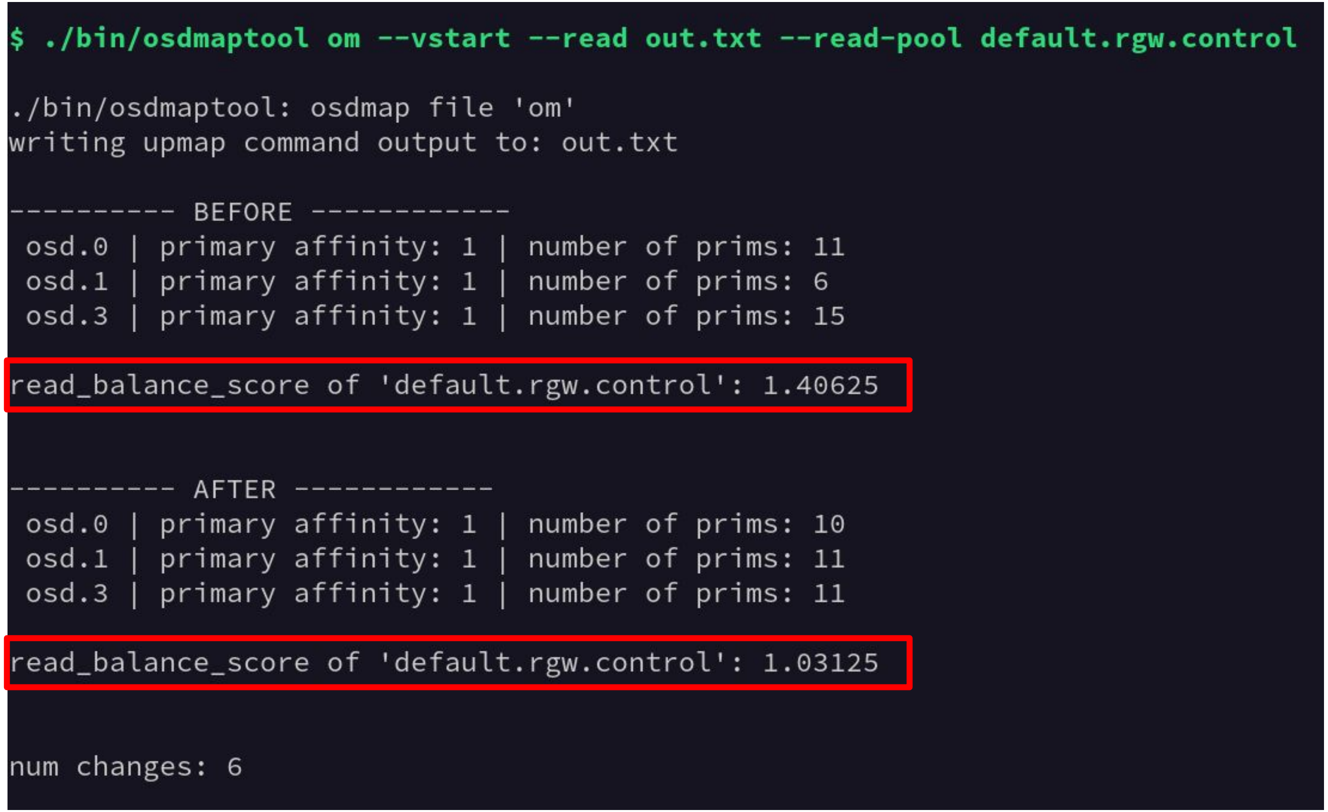
Run the upmap balancer first to make sure writes are balanced. In this case, the upmap balancer was unable to optimize further.



```
$ ./bin/osdmaptool om --upmap out.txt

./bin/osdmaptool: osdmap file 'om'
writing upmap command output to: out.txt
checking for upmap cleanups
upmap, max-count 10, max deviation 5
pools default.rgw.log cephfs.a.data default.rgw.control default.rgw.meta .mgr cephfs.a.meta .rgw.root
prepared 0/10 changes
Unable to find further optimization, or distribution is already perfect
```

Demo 2

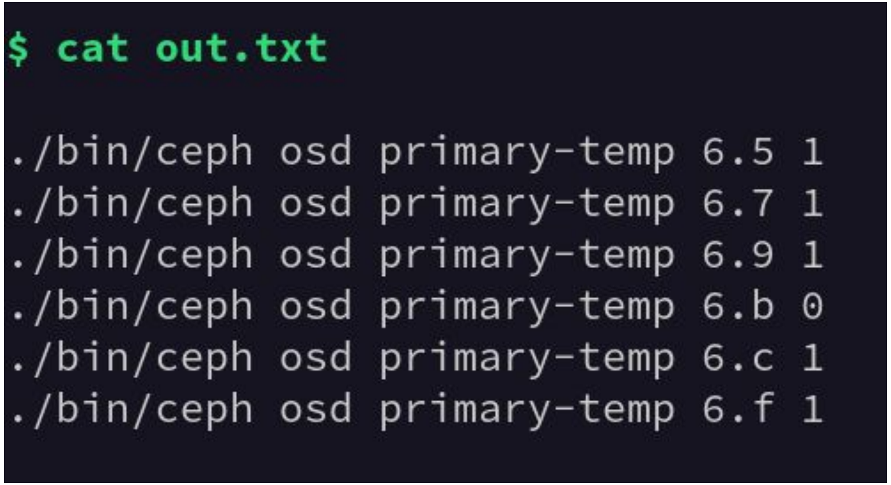
Run the read balancer, focusing on “default.rgw.control”:



```
$ ./bin/osdmaptool om --vstart --read out.txt --read-pool default.rgw.control

./bin/osdmaptool: osdmap file 'om'
writing upmap command output to: out.txt

---------- BEFORE ------------
 osd.0 | primary affinity: 1 | number of prims: 11
 osd.1 | primary affinity: 1 | number of prims: 6
 osd.3 | primary affinity: 1 | number of prims: 15

read_balance_score of 'default.rgw.control': 1.40625


---------- AFTER ------------
 osd.0 | primary affinity: 1 | number of prims: 10
 osd.1 | primary affinity: 1 | number of prims: 11
 osd.3 | primary affinity: 1 | number of prims: 11

read_balance_score of 'default.rgw.control': 1.03125


num changes: 6
```

Demo 2

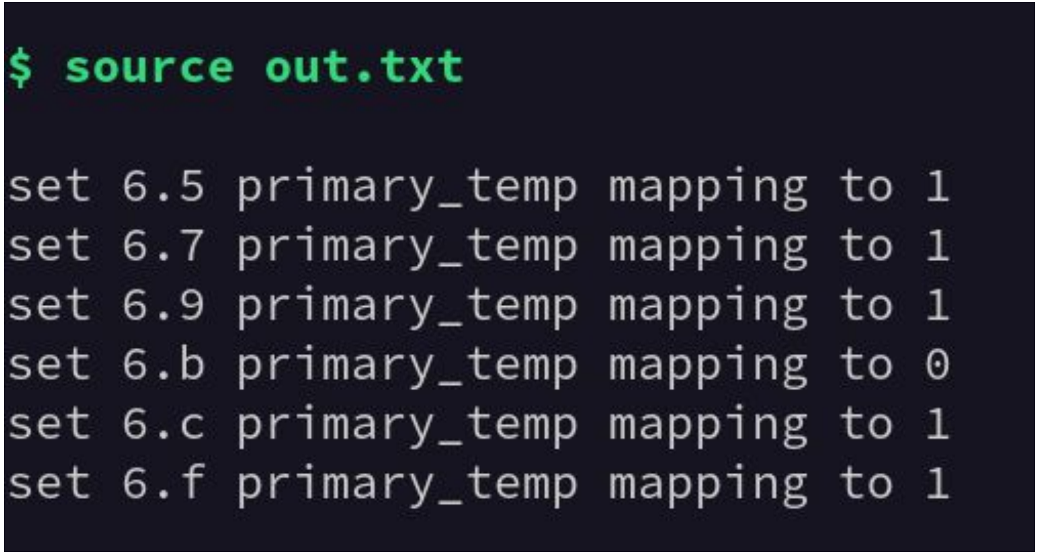
We can check to see what the balancer suggests in the “out.txt” file:



```
$ cat out.txt

./bin/ceph osd primary-temp 6.5 1
./bin/ceph osd primary-temp 6.7 1
./bin/ceph osd primary-temp 6.9 1
./bin/ceph osd primary-temp 6.b 0
./bin/ceph osd primary-temp 6.c 1
./bin/ceph osd primary-temp 6.f 1
```

Demo 2

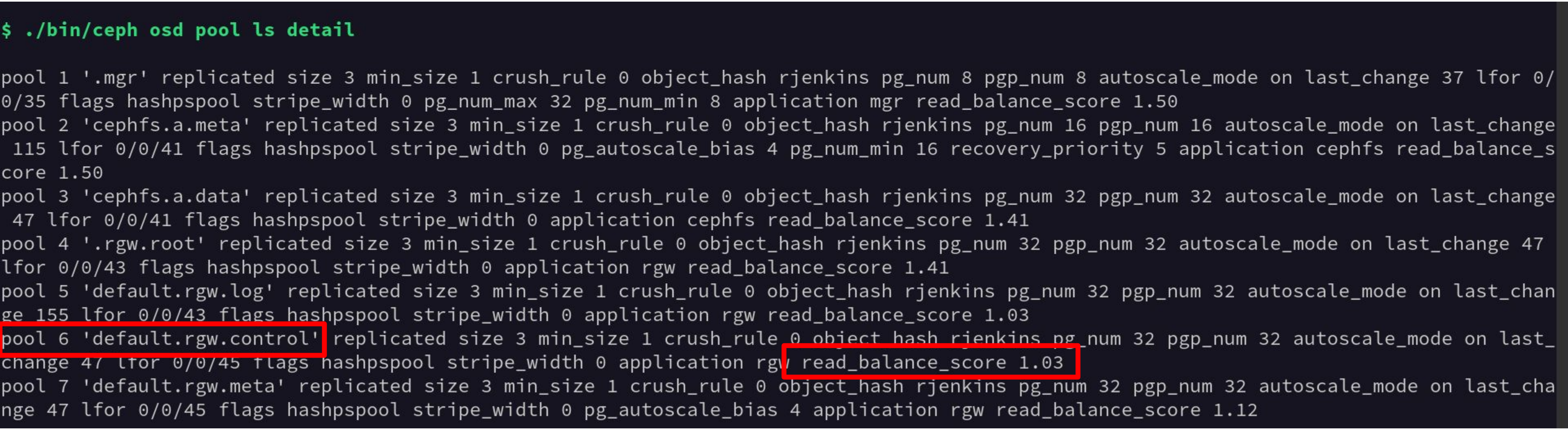
We can apply the file to a live system if we choose:



```
$ source out.txt

set 6.5 primary_temp mapping to 1
set 6.7 primary_temp mapping to 1
set 6.9 primary_temp mapping to 1
set 6.b primary_temp mapping to 0
set 6.c primary_temp mapping to 1
set 6.f primary_temp mapping to 1
```

Demo 2

Notice how the score has improved to 1.03 for “default.rgw.control”, which previously had a score of 1.41:



```
$ ./bin/ceph osd pool ls detail

pool 1 '.mgr' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 8 pgp_num 8 autoscale_mode on last_change 37 lfor 0/
0/35 flags hashpspool stripe_width 0 pg_num_max 32 pg_num_min 8 application mgr read_balance_score 1.50
pool 2 'cephfs.a.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 16 pgp_num 16 autoscale_mode on last_change
 115 lfor 0/0/41 flags hashpspool stripe_width 0 pg_autoscale_bias 4 pg_num_min 16 recovery_priority 5 application cephfs read_balance_s
core 1.50
pool 3 'cephfs.a.data' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change
 47 lfor 0/0/41 flags hashpspool stripe_width 0 application cephfs read_balance_score 1.41
pool 4 '.rgw.root' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_change 47
lfor 0/0/43 flags hashpspool stripe_width 0 application rgw read_balance_score 1.41
pool 5 'default.rgw.log' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_chan
ge 155 lfor 0/0/43 flags hashpspool stripe_width 0 application rgw read_balance_score 1.03
pool 6 'default.rgw.control' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_
change 47 lfor 0/0/45 flags hashpspool stripe_width 0 application rgw read_balance_score 1.03
pool 7 'default.rgw.meta' replicated size 3 min_size 1 crush_rule 0 object_hash rjenkins pg_num 32 pgp_num 32 autoscale_mode on last_cha
nge 47 lfor 0/0/45 flags hashpspool stripe_width 0 pg_autoscale_bias 4 application rgw read_balance_score 1.12
```

Scripts

The scripts used for both demos are available at this link:

https://github.com/ljflores/ceph_read_balancer