CL'SO

Understanding Ceph

One Performance Counter at a Time

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Scope

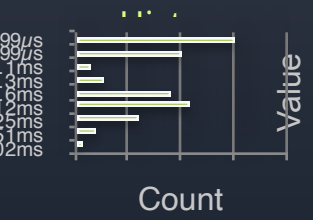
What can we learn by looking at Perf Counters?

Let's develop an intuition!

We won't go into analysis methods like the USE method

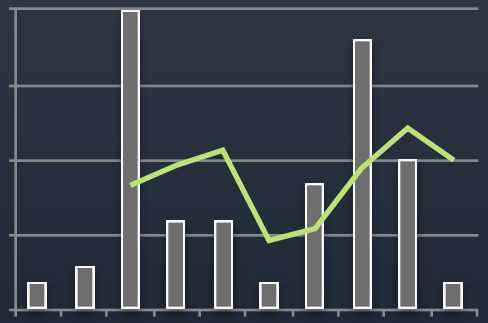
We look at *raw* performance counters.

No Prometheus, Grafana, etc.


Value
Count


Count
t1 t2 t3 t4 t5
t1 t3 t5 t7 t9


t1 t2 t3 t4 t5



What is a Perf Counter anyway?

A **metric** is a **measurement** of a service captured at runtime
(OpenTelemetry)

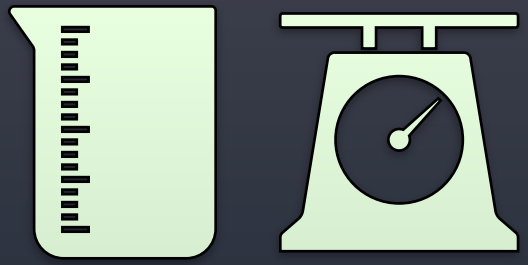
Values **captured** at **strategic** places
(me)

Examples:

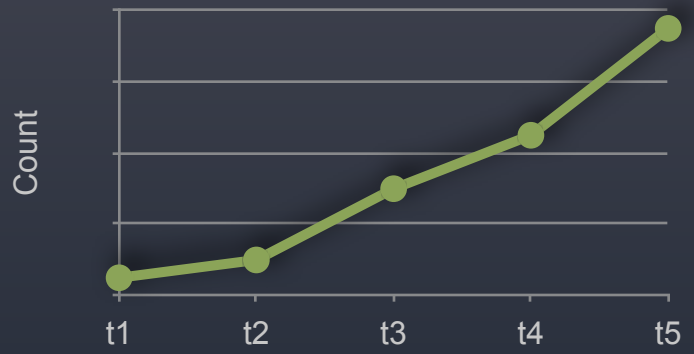
librados sends a write operation → increment osdop_write counter

OSD processed an operation → update op_latency

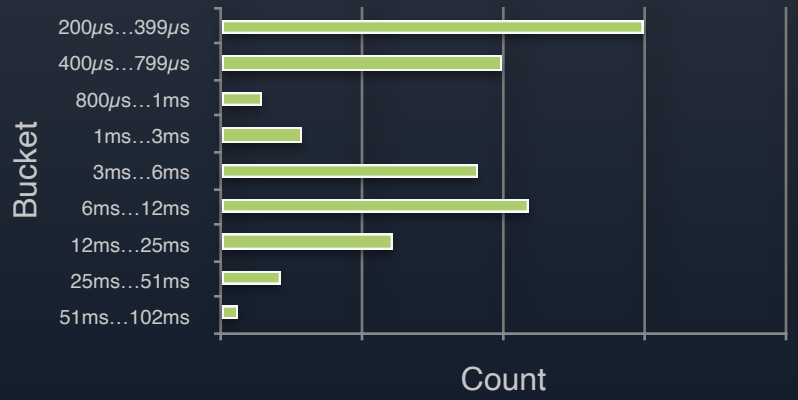
Gauge



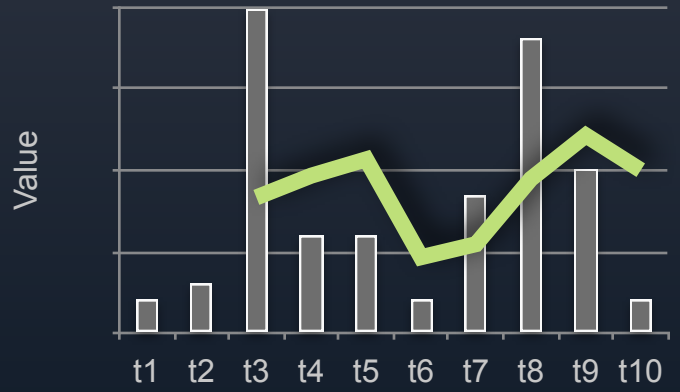
Counter



Histogram



Long Running Average



How to read Perf Counters?

```
# ceph daemon $out/radosgw.8000.asok perf dump
```

```
# ceph tell osd.0 perf dump
# ceph tell osd.0 perf schema
```

```
# ceph tell osd.0 counter dump
# ceph tell osd.0 counter schema
```

How to read performance counters?


```
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    }
  }
}
```


17k JSON

CL'SO

PERF COUNTER BROWSER

Found 880 perf counters in 41 groups

Group	Name	Description	Type	Tags
async messenger	msgr_connection_ready_timeouts	Number of not yet ready connections declared as dead	integer	mds, mgr, mon, client, osd
async messenger	msgr_connection_idle_timeouts	Number of connections closed due to idleness	integer	mds, mgr, mon, client, osd
async messenger	msgr_recv_messages	Network received messages	integer	mds, mgr, mon, client, osd
async messenger	msgr_send_messages	Network sent messages	integer	mds, mgr, mon, client, osd
async messenger	msgr_recv_bytes	Network received bytes	integer	mds, mgr, mon, client, osd
async messenger	msgr_send_bytes	Network sent bytes	integer	mds, mgr, mon, client, osd
async messenger	msgr_created_connections	Created connection number	integer	mds, mgr, mon, client, osd
async messenger	msgr_active_connections	Active connection number	integer	mds, mgr, mon, client, osd
async messenger	msgr_running_total_time	The [illegible] hread running	real	mds, mgr, mon, [illegible]

Calendar

MON=3 OSD=3 MGR=1 RGW=1 MDS=2 NFS=0 vstart.sh

880 counters

in

41 groups

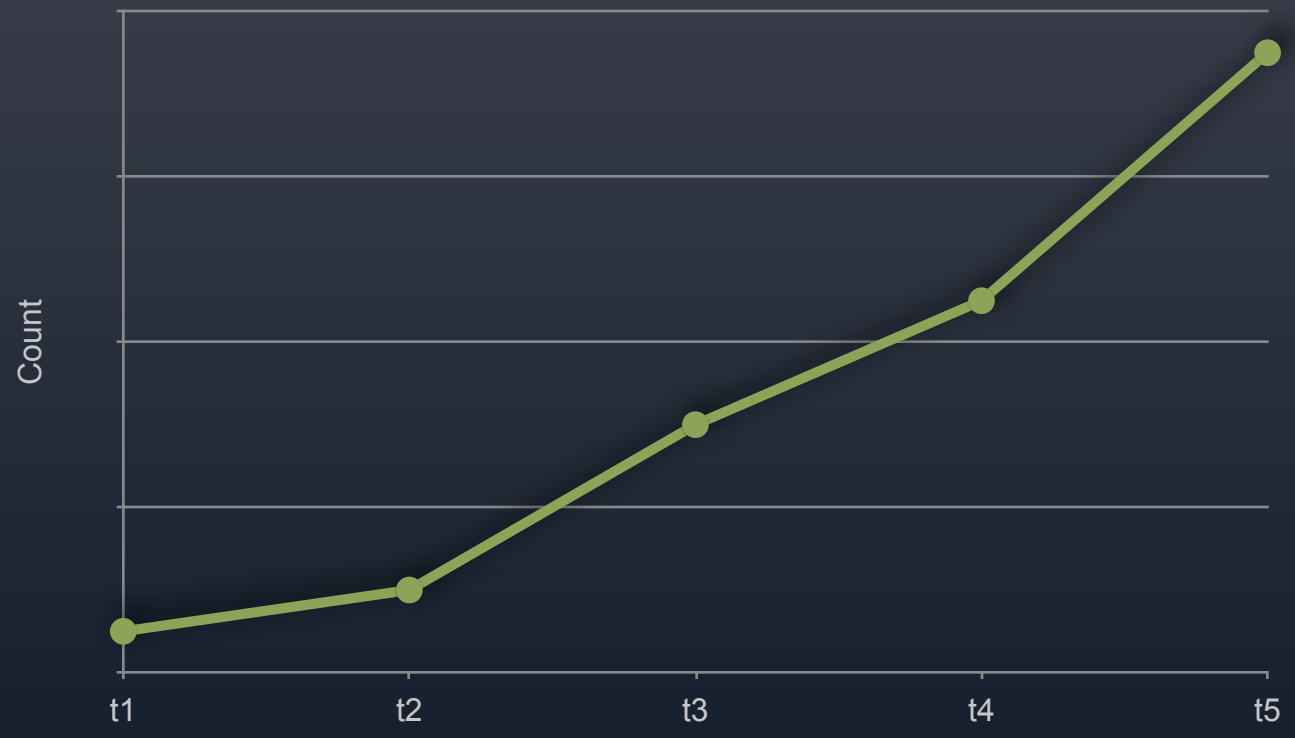
We focus on..

objecter (librados)

AsyncMessenger

osd

Counter



RGW: Single 4MB S3 PUT

2024-11-29T12:42:45.821+0100 7f0be538f6c0 1 beast: 0x7f0c53e61200: ::1 - testid [29/Nov/2024:12:42:45.758 +0100] "PUT /testbucket/13359 HTTP/1.1" 200 **4194304** - - - **latency=0.063001677s**

```
"rgw_op": {
    "put_obj_ops": 1,
    "put_obj_bytes": 4194304,
    ...
}
```

```
"rgw": {
    "req": 1,
    ...
}
```

CL'SO

RGW: Single 4MB S3 PUT

objecter.{osdop|omap}

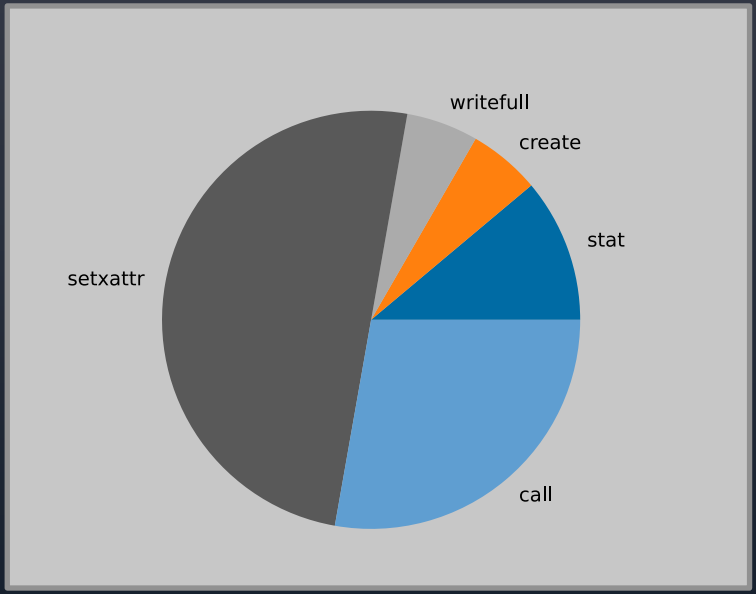
Table 1

"osdop_stat"	2
"osdop_create"	1
"osdop_read"	0
"osdop_write"	0
"osdop_writefull"	1
"osdop_writesame"	0
"osdop_append"	0
"osdop_zero"	0
"osdop_truncate"	0
"osdop_delete"	0
"osdop_mapext"	0
"osdop_sparse_read"	0
"osdop_clonerange"	0
"osdop_getxattr"	0
"osdop_setxattr"	9
"osdop_cmpxattr"	0
"osdop_rmxattr"	0
"osdop_resetxattrs"	0
"osdop_call"	5
"osdop_watch"	0
"osdop_notify"	0
"osdop_src_cmpxattr"	0
"osdop_pgls"	0
"osdop_pgls_filter"	0
"osdop_other"	0
“omap_wr"	0
“omap_rd"	0
“omap_del"	0

RGW: Single 4MB S3 PUT

objecter.{osdop|omap}_*

stat	2
create	1
writefull	1
setxattr	9
call	5



$\sum \ldots = 18$

RGW: Single 4MB S3 PUT

AsyncMessenger::Worker-*


```
{
  "msgr_recv_messages": 3,
  "msgr_send_messages": 3,
  "msgr_recv_bytes": 1481,
  "msgr_send_bytes": 4197637,
}
```

RGW: Single 4MB S3 PUT

$\sum$ (osdop_*, omap_*) = 18

$\sum$ msgr_send_messages = 3

objecter.op = 3

RGW: Single 4MB S3 PUT

$$\sum \text{msgr\_send\_bytes} - 4\text{MB}$$

$$\sim 4\text{k}$$

RGW: Single 4MB S3 PUT

osd.0


```
{
  "op": 6,
  "op_in_bytes": 0,
  "op_out_bytes": 224,
  "subop": 3,
  "subop_in_bytes": 4198251
}
```


osd.1


```
{
  "op": 4,
  "op_in_bytes": 0,
  "op_out_bytes": 0,
  "subop": 1,
  "subop_in_bytes": 4196187
}
```


osd.2


```
{
  "op": 4,
  "op_in_bytes": 4194304,
  "op_out_bytes": 0,
  "subop": 2,
  "subop_in_bytes": 2064
}
```

What does this teach us?

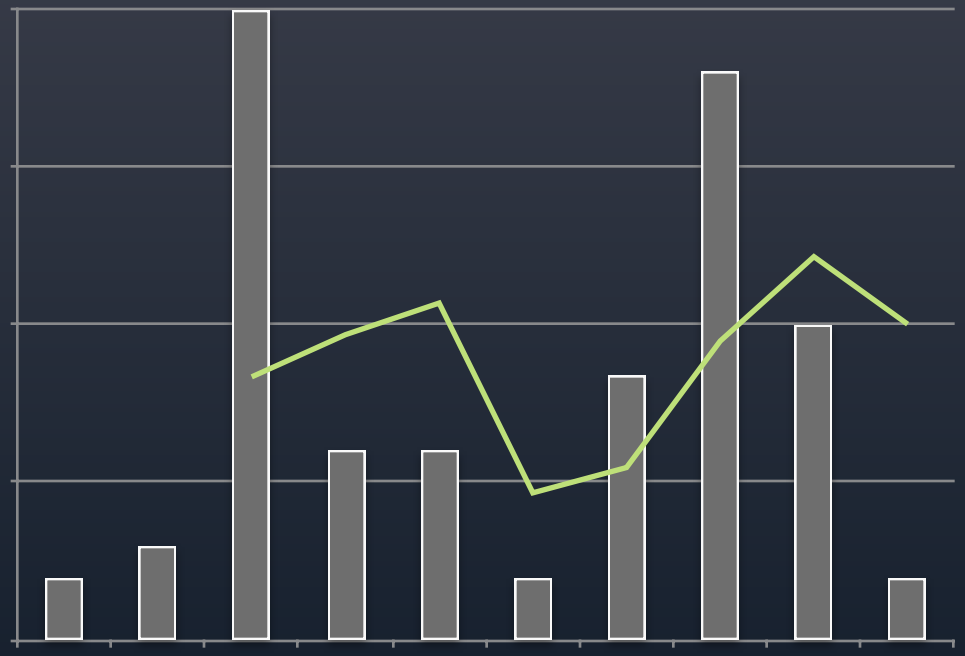
Op Mix

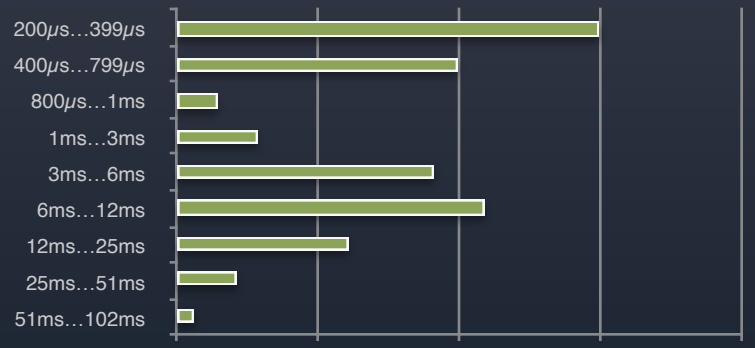
Op = [op, ..., op]

3 messages, 3 ops, 4k overhead

-> 18 queries and modifications to and from persistent data

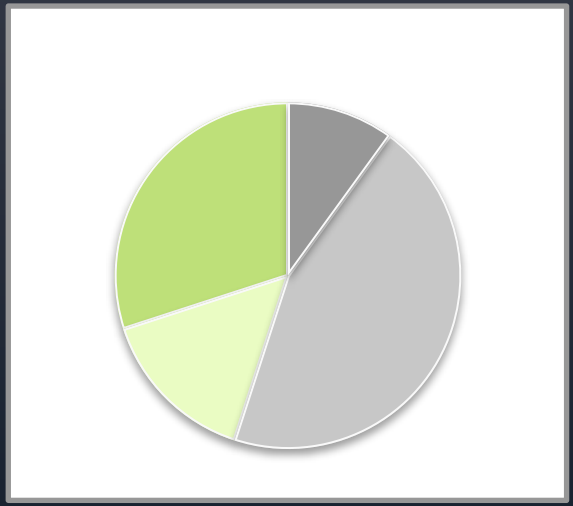
Latency

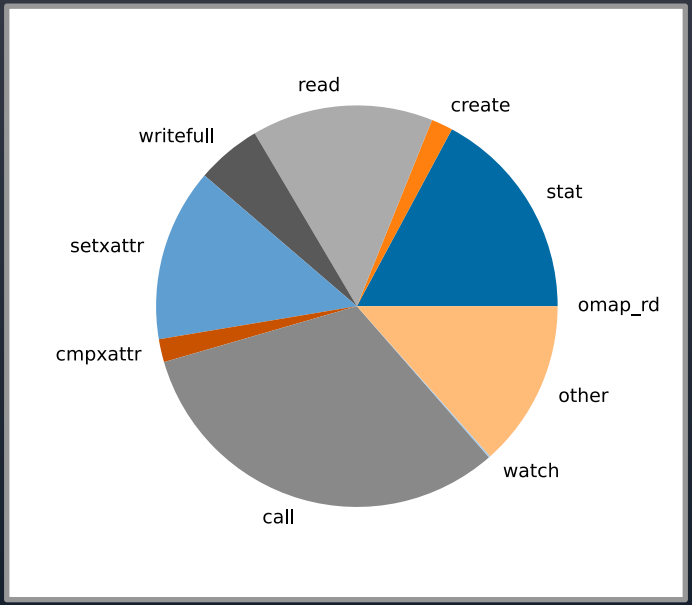



200μs…399μs
400μs…799μs
800μs…1ms
1ms…3ms
3ms…6ms
6ms…12ms
12ms…25ms
25ms…51ms
51ms…102ms

S3 Mixed Workload Benchmark

10% DELETE, 45% GET, 15% PUT, 30% STAT





stat	20947
create	2125
read	17836
writefull	6375
setxattr	17000
cmpxattr	2265
call	39004
watch	150
other	16417
omap$_{rd}$	2

S3 Mixed Workload Benchmark

Client / RGW:
objecter.op_latency 43ms

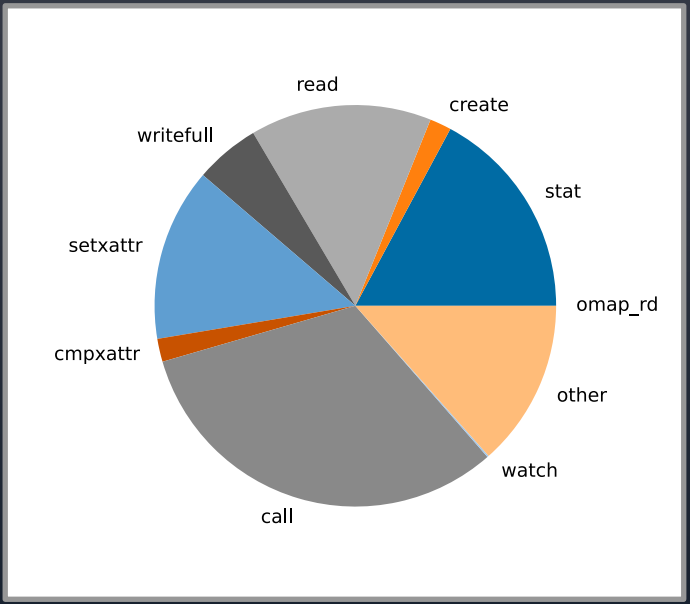
OSDs:
osd.op_latency

0: 41ms, 1: 44ms, 2: 39ms

S3 Mixed Workload Benchmark

~40 ms average latency

Is this actually meaningful?



S3 Mixed Workload Benchmark

osd.op_latency family:

osd.op_**w**_latency osd.op_**rw**_latency osd.op_**r**_latency

target	op_latency [ms]	op_r_latency [ms]	op_w_latency [ms]	op_rw_latency [ms]
osd.0	41	5	99	83
osd.1	44	5	98	82
osd.2	39	5	100	82

Histograms to the rescue

osd.0

41 ms average

5ms read

99ms write

83ms rw

Histograms to the rescue

op_latency captures every operation

op_r_latency_out_bytes_histogram	Histogram of operation latency (including queue time) + data read
op_w_latency_in_bytes_histogram	Histogram of operation latency (including queue time) + data written
op_rw_latency_in_bytes_histogram	Histogram of rw operation latency (including queue time) + data written
op_rw_latency_out_bytes_histogram	Histogram of rw operation latency (including queue time) + data read

CL'SO

Ceph 2D Histograms: latency x bytes

◪	0…511	512…1023	1K…2K	2K…4K	4K…8K	8K…16K	16K…32K	32K…64K	64K…128K	128K…256K	256K…512K	512K…1024K	1M…2M	2M…4M	4M…8M	8M…16M
<0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0ns…99µs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100µs…199µs	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200µs…399µs	31	1421	0	0	0	0	0	0	0	0	0	0	0	333	32	0
400µs…799µs	45	413	9	1	0	0	0	0	0	0	0	0	0	185	567	0
800µs…1ms	17	39	26	3	0	0	0	0	0	0	0	0	0	59	104	0
1ms…3ms	3	21	5	0	0	0	0	0	0	0	0	0	0	382	308	0
3ms…6ms	1	33	0	0	0	0	0	0	0	0	0	0	0	530	1168	0
6ms…12ms	2	38	0	0	0	0	0	0	0	0	0	0	0	313	1020	0
12ms…25ms	3	26	0	0	0	0	0	0	0	0	0	0	0	135	466	0
25ms…51ms	0	21	0	0	0	0	0	0	0	0	0	0	0	35	120	0
51ms…102ms	0	8	0	0	0	0	0	0	0	0	0	0	0	10	26	0
102ms…204ms	0	3	0	0	0	0	0	0	0	0	0	0	0	2	7	0

osd.op_r_latency_out_bytes_histogram

CL'SO

Ceph 2D Histograms: latency x bytes

◪	0…511	512…1023	1K…2K	2K…4K	4K…8K	8K…16K	16K…32K	32K…64K	64K…128K	128K…256K	256K…512K	512K…1024K	1M…2M	2M…4M	4M…8M	8M…16M
<0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0ns…99µs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100µs…199µs	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200µs…399µs	31	1421	0	0	0	0	0	0	0	0	0	0	0	333	32	0
400µs…799µs	45	413	9	1	0	0	0	0	0	0	0	0	0	185	567	0
800µs…1ms	17	39	26	3	0	0	0	0	0	0	0	0	0	59	104	0
1ms…3ms	3	21	5	0	0	0	0	0	0	0	0	0	0	382	308	0
3ms…6ms	1	33	0	0	0	0	0	0	0	0	0	0	0	530	1168	0
6ms…12ms	2	38	0	0	0	0	0	0	0	0	0	0	0	313	1020	0
12ms…25ms	3	26	0	0	0	0	0	0	0	0	0	0	0	135	466	0
25ms…51ms	0	21	0	0	0	0	0	0	0	0	0	0	0	35	120	0
51ms…102ms	0	8	0	0	0	0	0	0	0	0	0	0	0	10	26	0
102ms…204ms	0	3	0	0	0	0	0	0	0	0	0	0	0	2	7	0

osd.op_r_latency_out_bytes_histogram

CL'SO

Ceph 2D Histograms: latency x bytes

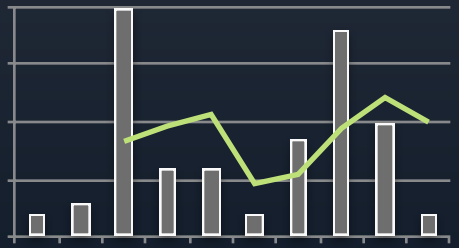
◪	0…511	512…1023	1K…2K	2K…4K	4K…8K	8K…16K	16K…32K	32K…64K	64K…128K	128K…256K	256K…512K	512K…1024K	1M…2M	2M…4M	4M…8M	8M…16M
<0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0ns…99µs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100µs…199µs	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200µs…399µs	31	1421	0	0	0	0	0	0	0	0	0	0	0	333	32	0
400µs…799µs	45	413	9	1	0	0	0	0	0	0	0	0	0	185	567	0
800µs…1ms	17	39	26	3	0	0	0	0	0	0	0	0	0	59	104	0
1ms…3ms	3	21	5	0	0	0	0	0	0	0	0	0	0	382	308	0
3ms…6ms	1	33	0	0	0	0	0	0	0	0	0	0	0	530	1168	0
6ms…12ms	2	38	0	0	0	0	0	0	0	0	0	0	0	313	1020	0
12ms…25ms	3	26	0	0	0	0	0	0	0	0	0	0	0	135	466	0
25ms…51ms	0	21	0	0	0	0	0	0	0	0	0	0	0	35	120	0
51ms…102ms	0	8	0	0	0	0	0	0	0	0	0	0	0	10	26	0
102ms…204ms	0	3	0	0	0	0	0	0	0	0	0	0	0	2	7	0

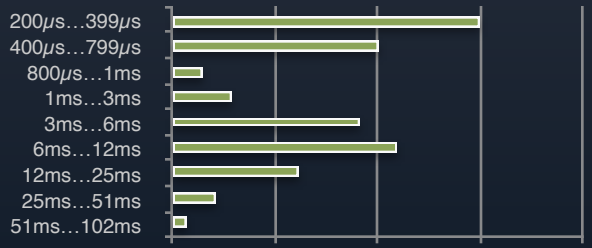
osd.op_r_latency_out_bytes_histogram

Recap

Counters - What is a S3 PUT?

Latency - Mixed S3 Workload





What's next?

Tracing (e.g bpftrace)

OSD Perf Queries

Collection at the Mgr: collection, Prometheus, etc

Bluestore metrics

Combining Ceph with system node exporter metrics

Messenger stats: cntop https://github.com/irq0/cntop

https://github.com/irq0/talk_ceph_perf_counters

CLYSO
Powered by ceph

Thank you!

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