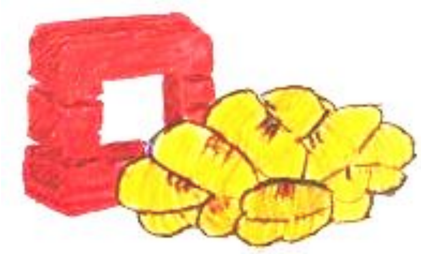
Storing metrics at scale with Gnocchi



Julien Danjou – *OpenStack Day France – 22 November 2016*

Hello!

I am Julien Danjou

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What's the problem?

And how we solve it.

Storing timeseries and resources index

In any infrastructure, you have to know what's running, for how long, doing what. You meter those things.

And then you need to store that.

Perfect solution

Scalable

Targeting cloud platforms where thousands of instances and resources pop up every day.

Storing and retrieving data should be fast.

Easy to use

Provide an API that makes it easy to program against the solution. Build any kind of solution easily (billing, capacity planning, statistical analysis…)

Easy to operate

Installation and operation should be easy for administrators used to standard UNIX tools.

Existing solutions

- Graphite
  - Not scalable
  - Poor code base
  - Not modulable
- InfluxDB
  - Does not work
  - Does not scale
- OpenTSDB
  - Need to set up Hadoop

…

Gnocchi – started in May 2014

Part of OpenStack Telemetry

Designed to solve Ceilometer storage issue back then.

But work stand-alone!

Easy to install

pip install gnocchi

Written in Python

With some standard used libraries (SQLAlchemy, Pandas…)

Free Software

Apache Licensed.

Documented

Everything is documented. No doc, no merge policy.

Distributed & resilient

Design to run on cloud platforms. Native high-availability and workload distribution support.

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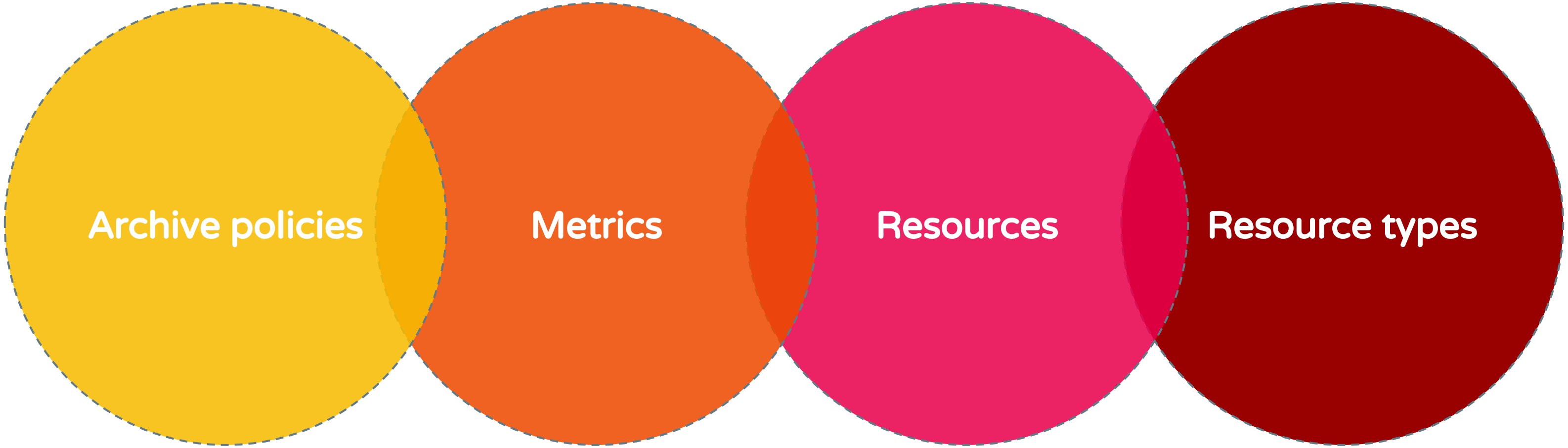
How it works

Basic things you need to know

Main object types



Archive policy

A measure storage policy attached to a metric. It determines how long measures will be kept in a metric and how they will be aggregated.

```
Keep data for:
  -   1 day with 5 minutes granularity
  -   1 month with 1 hour granularity.
Compute average, minimum and maximum.
```

“

Metric

An entity storing measures identified by an UUID. It can be attached to a resource using a name. How a metric stores its measure is defined by the archive policy it is associated to.

“

Measures

A datapoint tuple composed of timestamp and a value.

```
Timestamp:
2016-05-17T13:43:23+0200
Value: 42
```

“

Resource type

A schema that describes a resource: its attributes, their types and their constraints.

“

Resource

An entity representing anything in your infrastructure that you will associate metric with. It is identified by a unique ID and can carry attributes.

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Demo

As if you just installed it.

List archive policies and create a metric

```
➔ gnocchi archive-policy list
+--------+-------------+-------------------------------------------------------------------------+------------------------------------------------+
| name   | back_window | definition                                                              | aggregation_methods                            |
+--------+-------------+-------------------------------------------------------------------------+------------------------------------------------+
| high   |           0 | - points: 3600, granularity: 0:00:01, timespan: 1:00:00                 | std, count, 95pct, min, max, sum, median, mean |
|        |             | - points: 10080, granularity: 0:01:00, timespan: 7 days, 0:00:00        |                                                |
|        |             | - points: 8760, granularity: 1:00:00, timespan: 365 days, 0:00:00       |                                                |
| medium |           0 | - points: 1440, granularity: 0:01:00, timespan: 1 day, 0:00:00          | std, count, 95pct, min, max, sum, median, mean |
|        |             | - points: 168, granularity: 1:00:00, timespan: 7 days, 0:00:00          |                                                |
|        |             | - points: 365, granularity: 1 day, 0:00:00, timespan: 365 days, 0:00:00 |                                                |
| low    |           0 | - points: 12, granularity: 0:05:00, timespan: 1:00:00                   | std, count, 95pct, min, max, sum, median, mean |
|        |             | - points: 24, granularity: 1:00:00, timespan: 1 day, 0:00:00            |                                                |
|        |             | - points: 30, granularity: 1 day, 0:00:00, timespan: 30 days, 0:00:00   |                                                |
+--------+-------------+-------------------------------------------------------------------------+------------------------------------------------+
```

```
➔ gnocchi metric create --archive-policy-name low
+------------------------------------+-----------------------------------------------------------------------+
| Field                              | Value                                                                 |
+------------------------------------+-----------------------------------------------------------------------+
| archive_policy/aggregation_methods | std, count, 95pct, min, max, sum, median, mean                        |
| archive_policy/back_window         | 0                                                                     |
| archive_policy/definition          | - points: 12, granularity: 0:05:00, timespan: 1:00:00                 |
|                                    | - points: 24, granularity: 1:00:00, timespan: 1 day, 0:00:00          |
|                                    | - points: 30, granularity: 1 day, 0:00:00, timespan: 30 days, 0:00:00 |
| archive_policy/name                | low                                                                   |
| created_by_project_id              | admin                                                                 |
| created_by_user_id                 | admin                                                                 |
| id                                 | 95fdc8ff-1aed-4dd3-b65b-bfb53f91081b                                  |
| name                               | None                                                                  |
| resource/id                        | None                                                                  |
+------------------------------------+-----------------------------------------------------------------------+
```

Send & retrieve measures

```
➔ gnocchi measures add -m 2016-05-16T12:00:00@42 -m 2016-05-16T12:01:03@45 -m 2016-05-16T12:06:07@22
95fdc8ff-1aed-4dd3-b65b-bfb53f91081b
➔ gnocchi measures show 95fdc8ff-1aed-4dd3-b65b-bfb53f91081b
+---------------------------+-------------+---------------+
| timestamp                 | granularity |         value |
+---------------------------+-------------+---------------+
| 2016-05-16T00:00:00+00:00 |     86400.0 | 36.3333333333 |
| 2016-05-16T12:00:00+00:00 |      3600.0 | 36.3333333333 |
| 2016-05-16T12:00:00+00:00 |       300.0 |          43.5 |
| 2016-05-16T12:05:00+00:00 |       300.0 |          22.0 |
+---------------------------+-------------+---------------+
➔ gnocchi measures show --aggregation min 95fdc8ff-1aed-4dd3-b65b-bfb53f91081b
+---------------------------+-------------+-------+
| timestamp                 | granularity | value |
+---------------------------+-------------+-------+
| 2016-05-16T00:00:00+00:00 |     86400.0 |  22.0 |
| 2016-05-16T12:00:00+00:00 |      3600.0 |  22.0 |
| 2016-05-16T12:00:00+00:00 |       300.0 |  42.0 |
| 2016-05-16T12:05:00+00:00 |       300.0 |  22.0 |
+---------------------------+-------------+-------+
➔ gnocchi measures show --aggregation 95pct 95fdc8ff-1aed-4dd3-b65b-bfb53f91081b
+---------------------------+-------------+-------+
| timestamp                 | granularity | value |
+---------------------------+-------------+-------+
| 2016-05-16T00:00:00+00:00 |     86400.0 |  44.7 |
| 2016-05-16T12:00:00+00:00 |      3600.0 |  44.7 |
| 2016-05-16T12:00:00+00:00 |       300.0 | 44.85 |
| 2016-05-16T12:05:00+00:00 |       300.0 |  22.0 |
+---------------------------+-------------+-------+
```

Create a resource

```
➔ gnocchi resource-type create --attribute name:string --attribute host:string server
+-----------------+---------------------------------------------------------+
| Field           | Value                                                   |
+-----------------+---------------------------------------------------------+
| attributes/host | max_length=255, min_length=0, required=True, type=string |
| attributes/name | max_length=255, min_length=0, required=True, type=string |
| name            | server                                                  |
+-----------------+---------------------------------------------------------+
➔ gnocchi resource create --attribute name:www-42 --attribute host:compute1 --create-metric cpu:medium --create-metric
memory:low --type server `uuidgen`
+-----------------------+----------------------------------------------+
| Field                 | Value                                        |
+-----------------------+----------------------------------------------+
| created_by_project_id | admin                                        |
| created_by_user_id    | admin                                        |
| ended_at              | None                                         |
| host                  | compute1                                     |
| id                    | e4c2eab7-52ed-4447-bbcb-48cb04f12015         |
| metrics               | cpu: d51d8ba3-ab06-4f0c-af6c-d88dbac8c2a8    |
|                       | memory: 0240ceb8-d1d6-435d-a37c-f7f3bf99a388 |
| name                  | www-42                                       |
| original_resource_id  | E4C2EAB7-52ED-4447-BBCB-48CB04F12015         |
| project_id            | None                                         |
| revision_end          | None                                         |
| revision_start        | 2016-05-16T13:35:43.985927+00:00             |
| started_at            | 2016-05-16T13:35:43.985815+00:00             |
| type                  | server                                       |
| user_id               | None                                         |
+-----------------------+----------------------------------------------+
```

Update a resource

```
➔ gnocchi resource update --attribute host:compute2 --type server e4c2eab7-52ed-4447-bbcb-48cb04f12015
+-----------------------+----------------------------------------------+
| Field                 | Value                                        |
+-----------------------+----------------------------------------------+
| created_by_project_id | admin                                        |
| created_by_user_id    | admin                                        |
| ended_at              | None                                         |
| host                  | compute2                                     |
| id                    | e4c2eab7-52ed-4447-bbcb-48cb04f12015         |
| metrics               | cpu: d51d8ba3-ab06-4f0c-af6c-d88dbac8c2a8    |
|                       | memory: 0240ceb8-d1d6-435d-a37c-f7f3bf99a388 |
| name                  | www-42                                       |
| original_resource_id  | E4C2EAB7-52ED-4447-BBCB-48CB04F12015         |
| project_id            | None                                         |
| revision_end          | None                                         |
| revision_start        | 2016-05-16T13:37:38.140460+00:00             |
| started_at            | 2016-05-16T13:35:43.985815+00:00             |
| type                  | server                                       |
| user_id               | None                                         |
+-----------------------+----------------------------------------------+
```

See previous updates in JSON

```
➔ gnocchi resource history --format json --details e4c2eab7-52ed-4447-bbcb-48cb04f12015
[
  {
    "created_by_user_id": "admin",
    "started_at": "2016-05-16T13:35:43.985815+00:00",
    "user_id": null,
    "revision_end": "2016-05-16T13:37:38.140460+00:00",
    "ended_at": null,
    "created_by_project_id": "admin",
    "metrics": "cpu: d51d8ba3-ab06-4f0c-af6c-d88dbac8c2a8\nmemory: 0240ceb8-d1d6-435d-a37c-f7f3bf99a388",
    "host": "compute1",
    "revision_start": "2016-05-16T13:35:43.985927+00:00",
    "project_id": null,
    "type": "server",
    "id": "e4c2eab7-52ed-4447-bbcb-48cb04f12015",
    "name": "www-42"
  },
  {
    "created_by_user_id": "admin",
    "started_at": "2016-05-16T13:35:43.985815+00:00",
    "user_id": null,
    "revision_end": null,
    "ended_at": null,
    "created_by_project_id": "admin",
    "metrics": "cpu: d51d8ba3-ab06-4f0c-af6c-d88dbac8c2a8\nmemory: 0240ceb8-d1d6-435d-a37c-f7f3bf99a388",
    "host": "compute2",
    "revision_start": "2016-05-16T13:37:38.140460+00:00",
    "project_id": null,
    "type": "server",
    "id": "e4c2eab7-52ed-4447-bbcb-48cb04f12015",
    "name": "www-42"
  }
]
```

Send & get measures on a metric attached to a resource & search

```
➔ gnocchi measures add -m 2016-05-16T12:00:00@42 -m 2016-05-16T12:01:03@45 -m 2016-05-16T12:06:07@22 --resource-id
e4c2eab7-52ed-4447-bbcb-48cb04f12015 cpu
➔ gnocchi measures show --resource-id e4c2eab7-52ed-4447-bbcb-48cb04f12015 cpu
+---------------------------+-------------+---------------+
| timestamp                 | granularity |         value |
+---------------------------+-------------+---------------+
| 2016-05-16T00:00:00+00:00 |     86400.0 | 36.3333333333 |
| 2016-05-16T12:00:00+00:00 |      3600.0 | 36.3333333333 |
| 2016-05-16T12:00:00+00:00 |        60.0 |          42.0 |
| 2016-05-16T12:01:00+00:00 |        60.0 |          45.0 |
| 2016-05-16T12:06:00+00:00 |        60.0 |          22.0 |
+---------------------------+-------------+---------------+

➔ gnocchi resource search --type server host=compute2
+----------------------------+--------+------------+---------+----------------------------+----------+----------------------------+--------------+
| id                         | type   | project_id | user_id | started_at                 | ended_at | revision_start             | revision_end |
+----------------------------+--------+------------+---------+----------------------------+----------+----------------------------+--------------+
| e4c2eab7-52ed-4447-bbcb-   | server | None       | None    | 2016-05-16T13:35:43.985815 | None     | 2016-05-16T13:37:38.140460+ | None         |
| 48cb04f12015               |        |            |         | +00:00                     |          | 00:00                      |              |
+----------------------------+--------+------------+---------+----------------------------+----------+----------------------------+--------------+
```

Also integrated with...

Ceilometer

Store your OpenStack metrics with the Gnocchi driver.

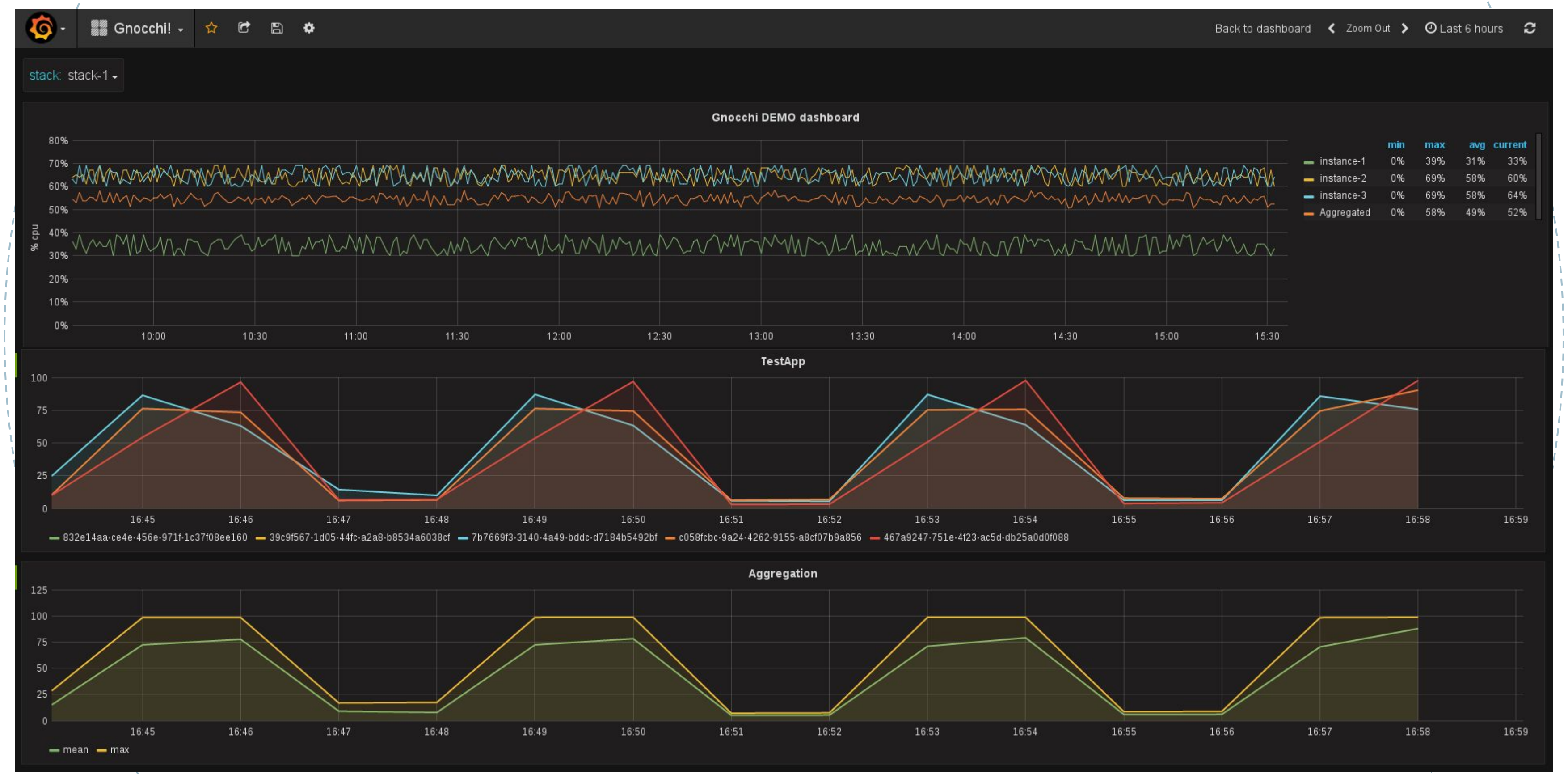
collectd, statsd

Store your collectd metrics with https://github.com/jd/collectd-gnocchi or use the gnocchi-statsd daemon to send data using statsd protocol

Nagios

Store perfdata using https://github.com/sileht/gnocchi-nagios

Grafana support



	min	max	avg	current
instance-1	0%	39%	31%	33%
instance-2	0%	69%	58%	60%
instance-3	0%	69%	58%	64%
Aggregated	0%	58%	49%	52%

More awesome features

Search by metric value, compute aggregations

Look into metrics value and search for outliers.

Compute aggregation across several metrics.

Batching

Send batch of measures in one single HTTP call.

Trigger alarms

Using Aodh to evaluate your alarms.

Compression

Using LZ4 compression to compress data on the fly. Fast, reduce storage usage between x2-5.

Statsd support

If you're already a Graphite user or you're polling tool support statsd (e.g. collectd), it's compatible.

Multi-tenant

ACL that guarantees your different tenants can't see each other resources. But the admin can see everything. Customizable.

HTTP REST API

That's what's used by the `gnocchi' CLI. Add --debug to discover the HTTP requests, or read the API specs!

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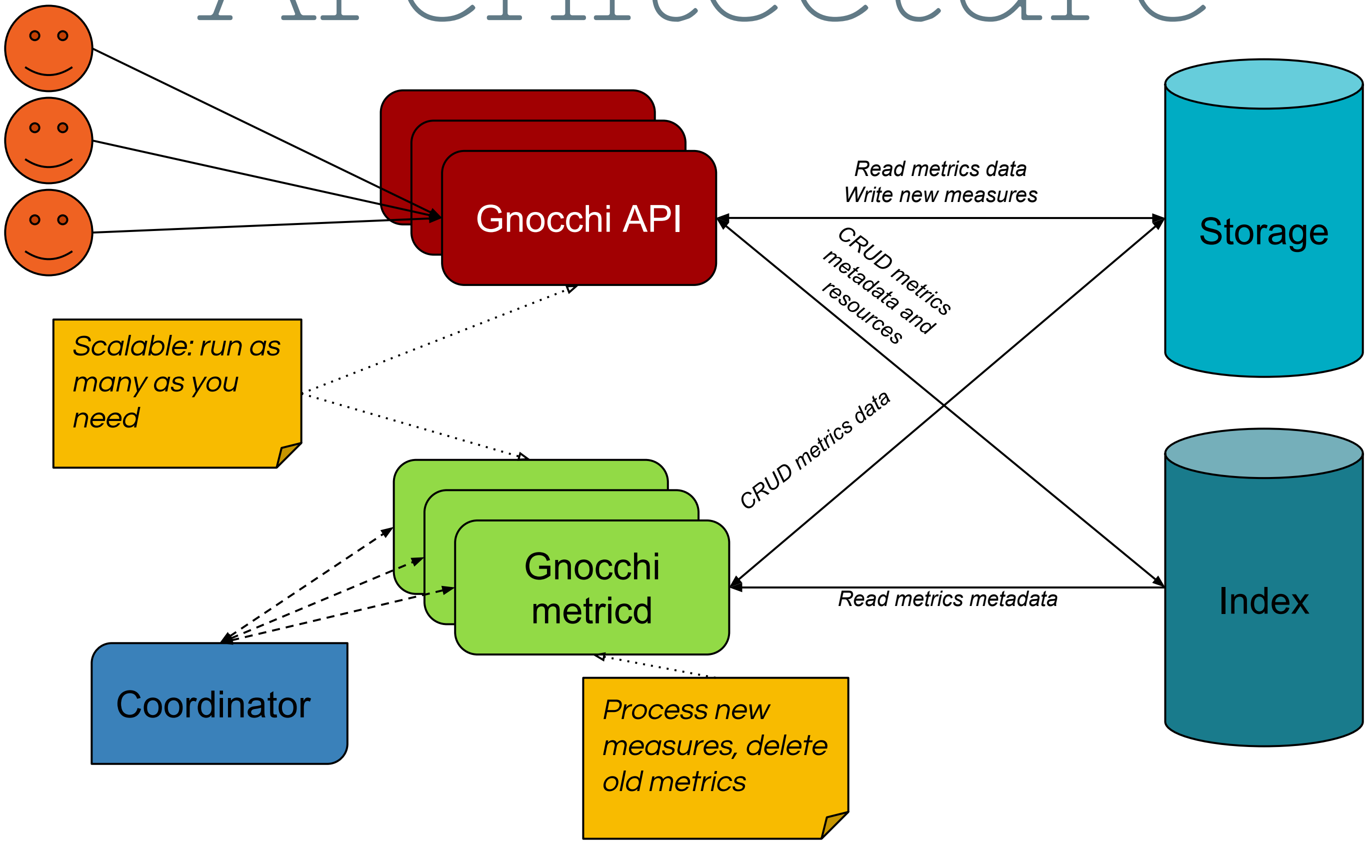
Under the hood

How the magic is working.

Architecture



Gnocchi API

Read metrics data
Write new measures

CRUD metrics metadata and resources

Storage

Scalable: run as many as you need

CRUD metrics data

Gnocchi metricd

Read metrics metadata

Index

Coordinator

Process new measures, delete old metrics

Backends

Index

Any RDBMS support by SQLAlchemy. Best choice: **PostgreSQL**. Though **MySQL** is also supported.

Storage

Simple deployment? **Plain files** (with NFS if you want).

Scalable and robust? Go for **Ceph**.

Got OpenStack? Leverage **Swift**.

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Performances

Does it scale?

Benchmarks

Hardware

- 3 physical hosts
  - 24 cores
  - 256 GB RAM
  - 10K RPM 1 TB hard drives
- 1 Gb network

Software

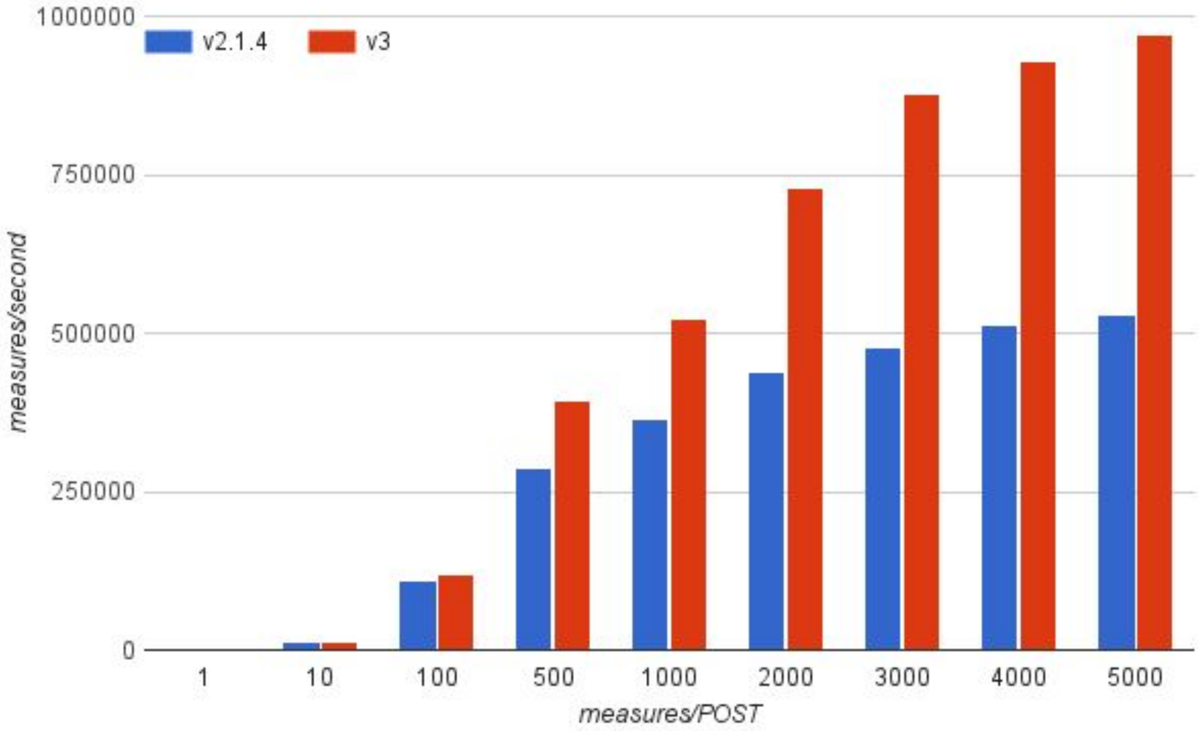
- **PostgreSQL 9.2.15**
- **Redis 3.0.6**
- **Ceph 10.2.1 (3 nodes, 20 OSD, 1 replica)**

Write throughput

Up to **50% speed gain** between v2 and v3

Up to 1M measures/s processed
(with batch of 5K measures)

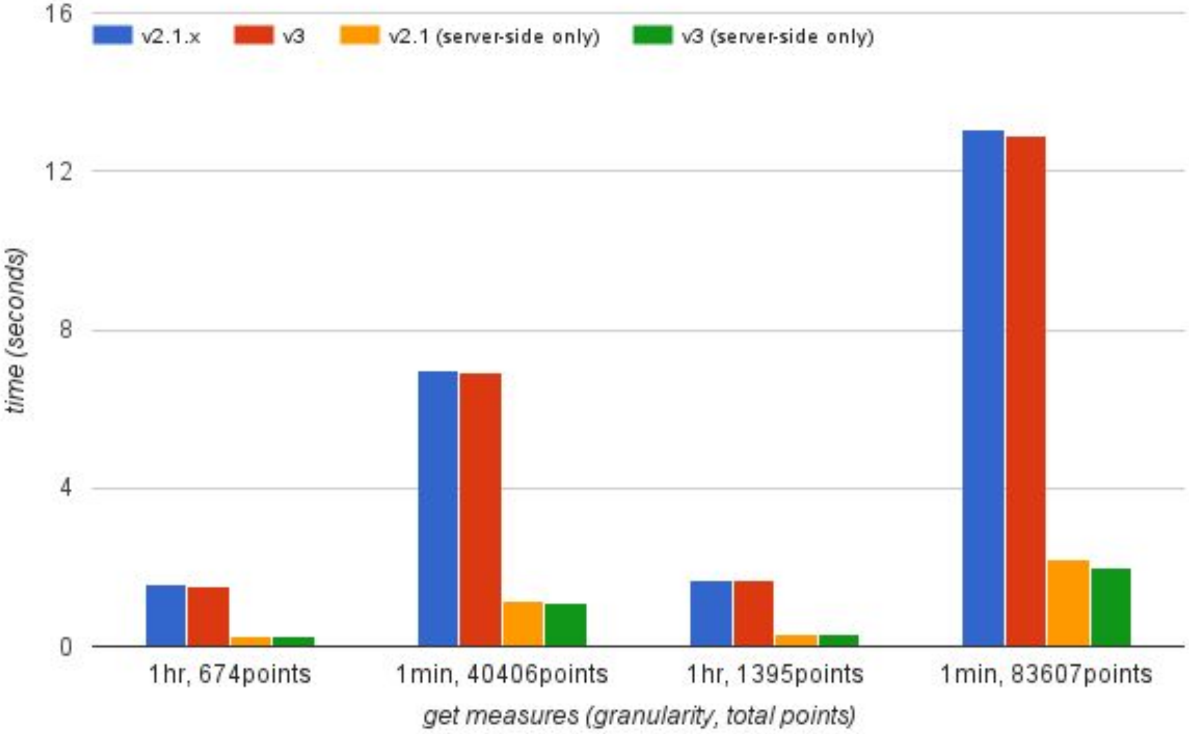
13K measures/s processed
(with batch of 10 measures)



Read throughput

No speed gain between v2 and v3

40K measures/s for a single request (though it can handle several thousands in parallel)

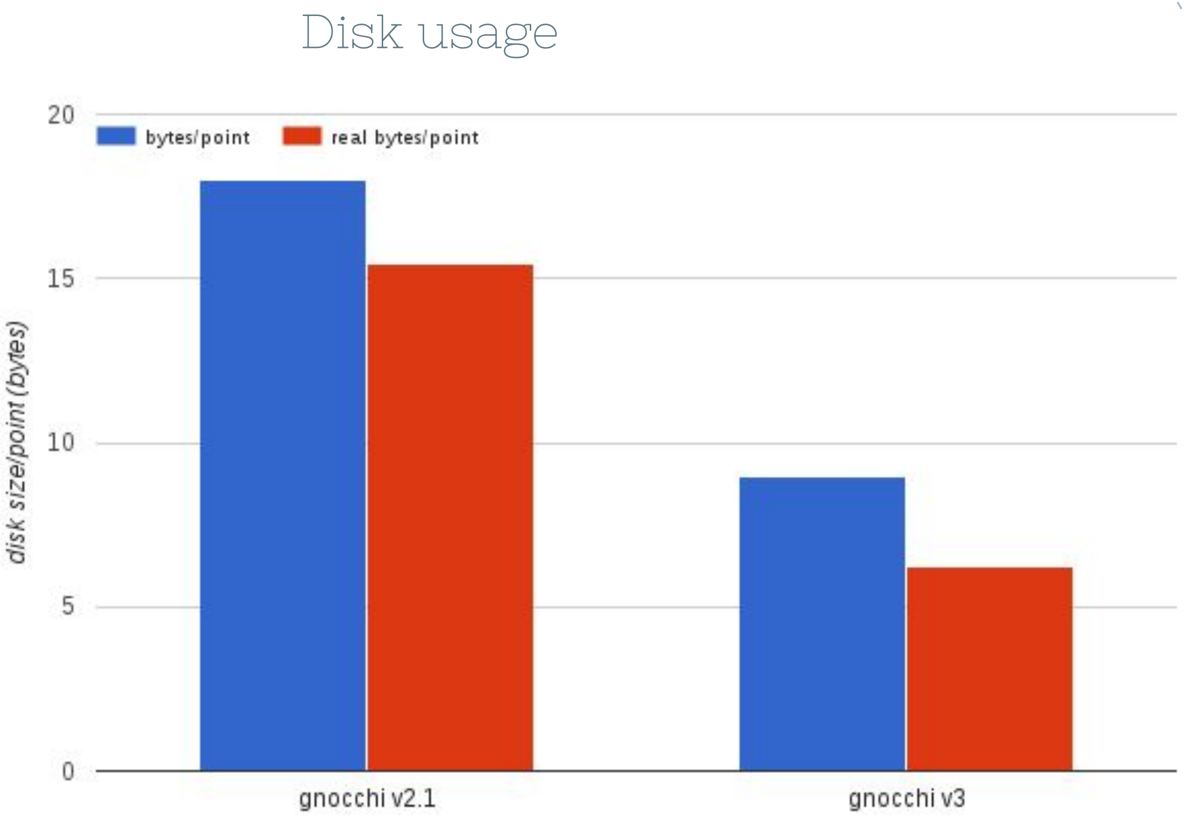


6.25 bytes per point on average

0.04 bytes per point for best case scenario

9 bytes per point for worst case scenario

Compared to 16 bytes in all cases previously



Thanks!

http://gnocchi.xyz

Any questions?

You can find me at @juldanjou & julien@danjou.info