Prometheus Deep Dive

Monitoring. At scale.

Richard Hartmann & Ben Kochie,
@TwitchiH

2018-11-15

Who are we?

- Richard ”RichiH” Hartmann
  - Swiss army chainsaw at SpaceNet
  - Project lead for building one of the most modern datacenters in Europe
  - Debian Developer
  - FOSDEM, DebConf, DENOGx, PromCon staff
- Ben ”SuperQ” Kochie
  - Staff engineer at GitLab
  - Bit plumber
  - Retired SRE
  - FOSDEM infrastructure, PromCon staff

Show of hands

- Who has heard of Prometheus?
- Who is considering to use Prometheus?
- Who is POCing Prometheus?
- Who uses Prometheus in production?

Prometheus 101

- Inspired by Google's Borgmon
- Time series database
- int64 timestamp, float64 value
- Ecosystem of instrumentation & exporters
- Not for events
  - Logging
  - Tracing (more on that later)
  - etc.
- Dashboarding via Grafana

Main selling points

- Highly dynamic, built-in service discovery
- No hierarchical model, n-dimensional label set
- PromQL: for processing, graphing, alerting, and export
- Simple operation
- Highly efficient

Cloudy with a chance of buzzwords

- So it's built with highly dynamic environments in mind
- It's the second project to ever join CNCF and the de facto standard in cloud-native monitoring
- Kubelets, sidecars, microservices, ALL the cloud-native
- But it's a monolithic application
- ...why?

Resilience, resilience, and also resilience

- What do you need for operations?
  - Power and cooling
  - Network connectivity
  - Observability, a.k.a. Monitoring
- The rest you can fix

Three main features

- Storage backend
  - Caveat: Prometheus 2.0 comes with storage v3
- Staleness handling
- Remote read & write API is now stable-ish
- Links to in-depth talks about these features are at the end

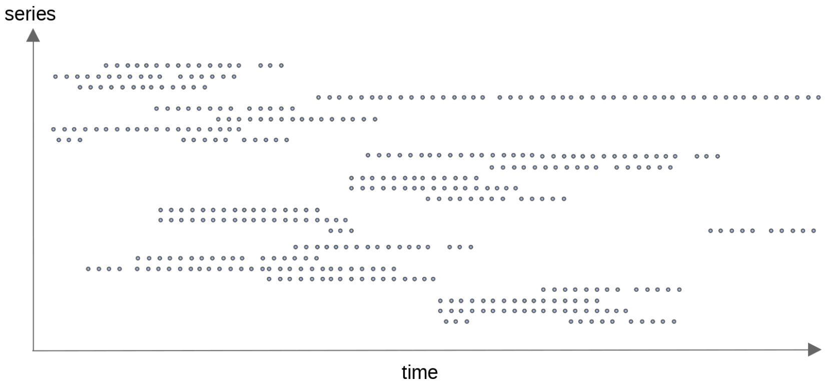
Prometheus 1.x

- We used to have one file per time series
- ..and one common index for all of time
- Relatively easy to implement
- Pretty efficient
- Why change?

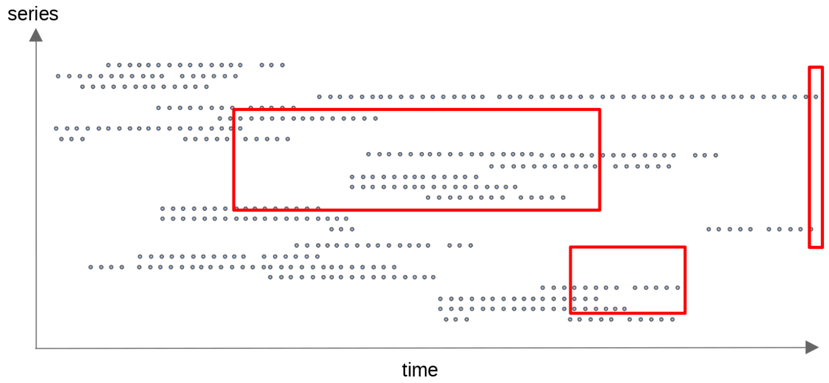
Churn

- Churn was becoming more and more of a problem
- There's a company with a 15 minute maximum lifetime for their containers
- If you have a lot of files which might contain data for any given time frame, you need to look at all of them

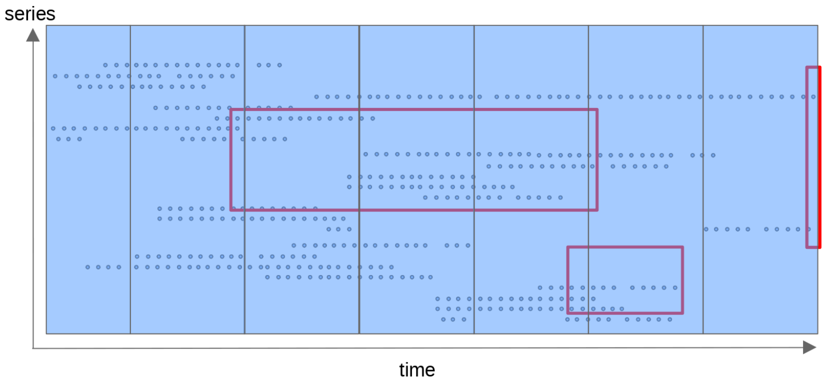
One file per series



Selection



Blocks



Test setup

- Kubernetes cluster with dedicated Prometheus nodes
- 800 microservice instances and Kubernetes components
- 120k samples/sec
- 300k active time series
- Swap out 50% of all pods every 10 minutes

Results

- 15x reduction in memory usage
- 6x reduction in CPU usage
- 80-100x reduction in disk writes
- 5x reduction in on-disk size
- 4x reduction in query latency on expensive queries
- Want to reproduce?
  `https://github.com/prometheus/prombench`

Playing nicely with others

- We now have a stable-ish remote read/write API
- Twelve integrations for this API
- Ongoing work to send write-ahead-log over the wire to fill gaps

Security & quality

- CNCF sponsored external code review by Cure53
- Focussed on security, but this always means looking at stability as well
- Keep in mind that Prometheus willfully ignored most security considerations
- Encryption, authentication, and authorization currently need to be handled via reverse proxies
- We will be changing Prometheus to support security out-of-the-box

Release stability

- Every single release since 2.0.0 has had issues
- Some bugs and some human mistakes in the release process
- Always running latest is the cloud-native approach, but this is still not acceptable
- ..especially if every single version has its issues
- We put in more checks and balances to ensure cleaner releases going forward
- If there are bugs we can't get rid of, we go into feature moratorium
- 2.3.2 is the first fully stable release in the 2.x train

Fixed release cycle

- Every six weeks, we mark a new RC
- Cycle is relative to previous RC, not previous release
- RC is published and iterated upon as long as there are issues
- Release handling cycles between team members to ensure several people are able to release

Quick is not quick enough

- Brian Brazil optimized PromQL
- 5x faster for time vector functions
- 100x reduction in garbage to collect

Problem statement

- Long-term storage is the last remaining major feature left untackled
- Fundamentally, Prometheus operates as distinct data islands
- As there’s no backfill, data dies along with its instance by default

Solutions

- Storage v3 supports backups efficiently and effectively
- Remote read-write allows you to integrate with a growing list of projects and products, e.g. Cortex
- On storage level, there are object storage backends for Prometheus, e.g. Thanos
- Remote API can now send WAL over the wire to fill gaps in data
- There are twelve different systems which are able to ingest Proemtheus data this way
- We deliberately do no endorse any particular approach or solution; this might change over time

ACID databases...

- **A**tomicity - since 1.x
- **C**onsistency - since 1.x
- **I**solation - will happen within 2.x
- **D**urability - since 2.0

Isolation

- Each append action gets a write ID (64 bit monotonic counter)
- Every sample’s write ID is noted along with value and timestamp
- Any append action which has not yet been committed, or has been rolled back, is ignored at query time
- We keep write IDs in memory; if we restart or crash, the atomicity of the write ahead log will protect us

Humble aspirations

- When we say that we want to change how the world does monitoring, we mean it
- One of our most powerful features are labels
- Labels are encoded in our exposition format
- Some third-party projects and vendors have an issue with supporting a ”competing” project

What do?

- We are spinning out Prometheus’ exposition format
- Face-to-face kick-off last August at Google London
- Independent CNCF member project, IETF RFC, test suite, etc
- We finished our technical discussions last week and I am currently writing the Internet Draft
- `https://github.com/RichiH/OpenMetrics`
- Prometheus 2.5 has experimental OpenMetrics support

Beyond metrics

- OpenMetrics supports more than just metrics
- Every single data point in a time series can point to one single event
- Especially useful if you emit one trace id per histogram bucket
- Some integrations already support this concept, e.g. OpenCensus
- Ingestors are free to discard this optional data, e.g. Prometheus

Bringing observability together

- OpenTracing already on board with this effort
- Will hammer out more details and have a face-to-face during CloudNativeCon Seattle this December
- There will be an observability sidetrack
- Long-term goal is one common, modular, well-engineered standard under a new name

First committers to adopt, too many to list all

- Cloudflare
- CNCF at large
- GitLab
- Google
- Grafana
- InfluxData
- Kausal.co
- Oath.com / Yahoo / Verizon
- RobustPerception
- SpaceNet
- Uber

Generally speaking...

- Yes, we want to change the world
- Simple and resilient operation of Prometheus remains a core goal
- The path from raw data to reliable alerts is the single most important user contract we have
- More project and software integrations... and we're talking to hardware vendors as well
- Supporting tomorrow's 10x scale today

Relevant talks

- Storing 16 Bytes at Scale: `https://promcon.io/2017-munich/talks/staleness-in-prometheus-2-0/`
- Staleness and Isolation in Prometheus 2.0: `https://promcon.io/2017-munich/talks/staleness-in-prometheus-2-0/`
- Social aspects of change: `https://promcon.io/2017-munich/talks/social-aspects-of-change/`

Further reading

- Prometheus 2017 Dev Summit: `https://docs.google.com/document/d/1DaHFao0saZ3MDt9yuuxLaCQg8WGad08s44i3cxSARcM/edit`
- Prometheus 2018 Dev Summit: `https://docs.google.com/document/d/1-C5PycocOZEVIPrmM1hn8fBelShqtqiAmFptoG4yK70/edit`
- OpenMetrics: `https://github.com/RichiH/OpenMetrics`
- This and other talks: `https://github.com/RichiH/talks/`

Thanks!

Thanks for listening!

Questions?