Prometheus: is it ready for Network Monitoring?

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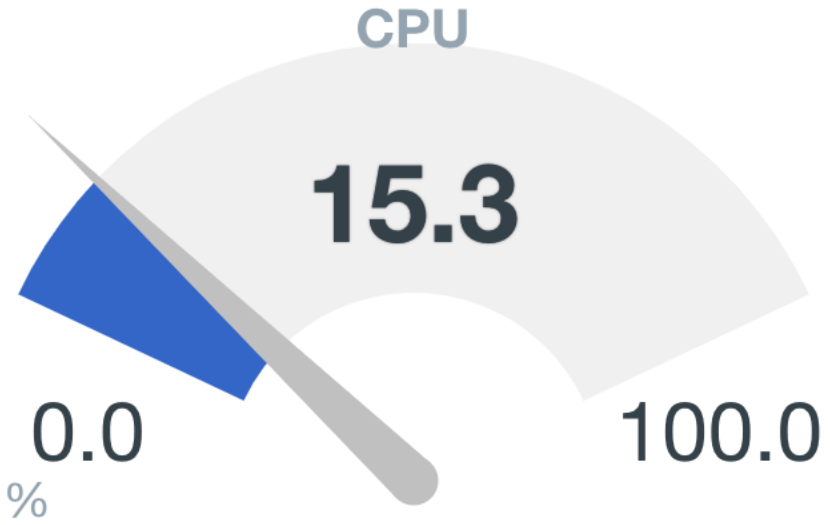
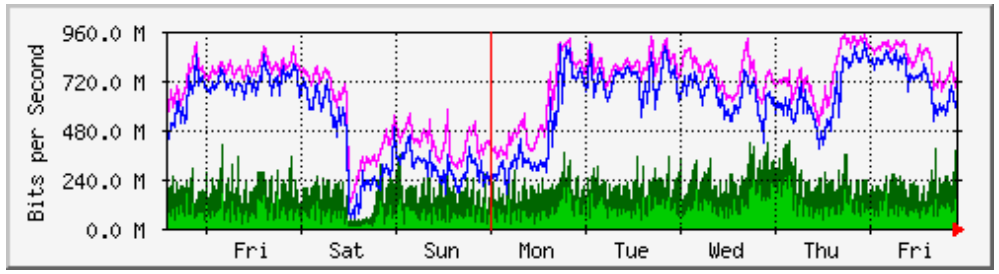
To manage our networks, we need to collect measurements (metrics)

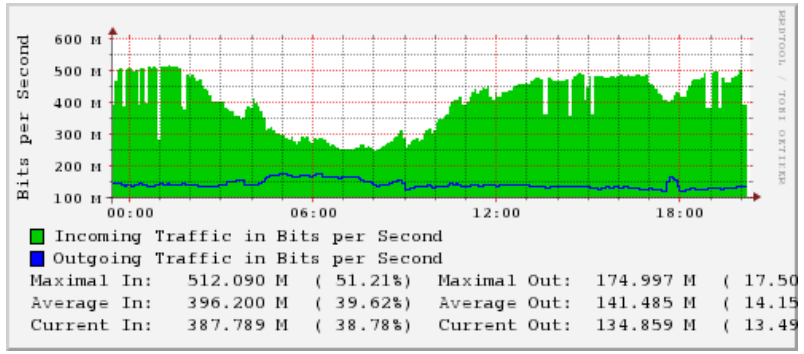


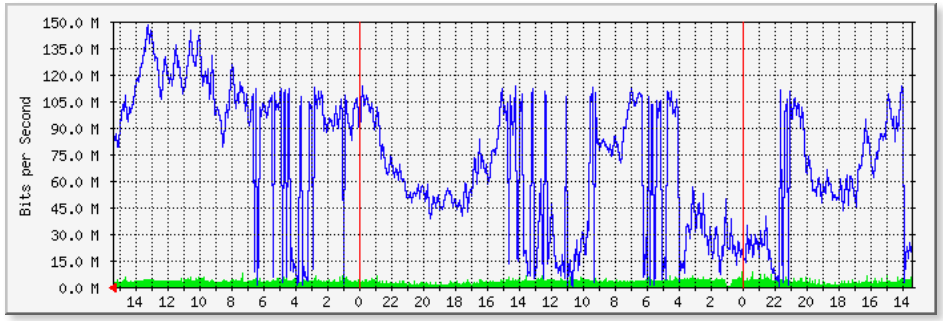
(and view historical data, identify trends, generate alerts…)

Many OSS network monitoring tools use **RRDtool** internally for storing and graphing time series data

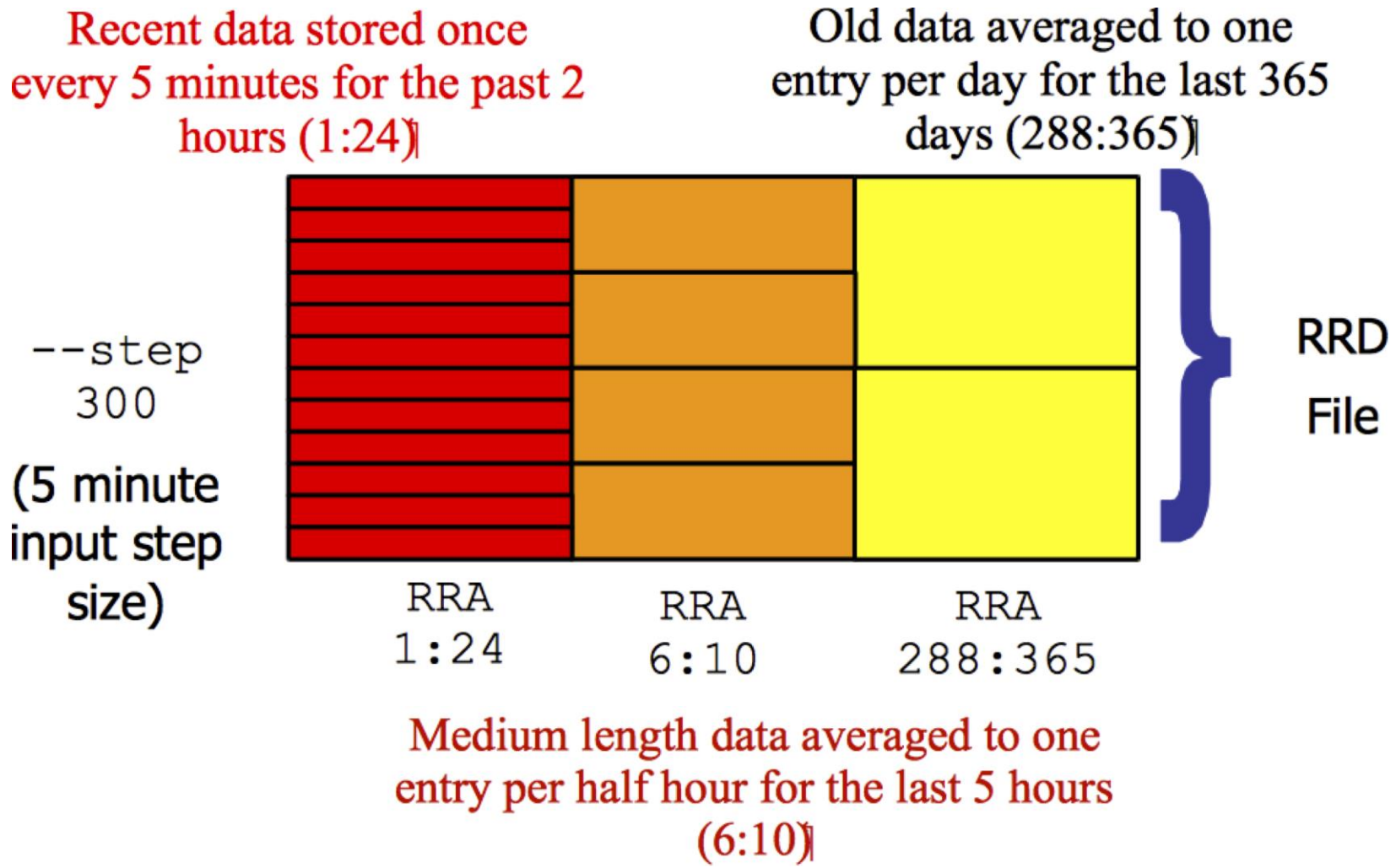
- Cacti
- Smokeping
- LibreNMS
- Check_mk
- NfSen
- Munin
- …







RRDtool database file format (example)



Problems with RRDtool

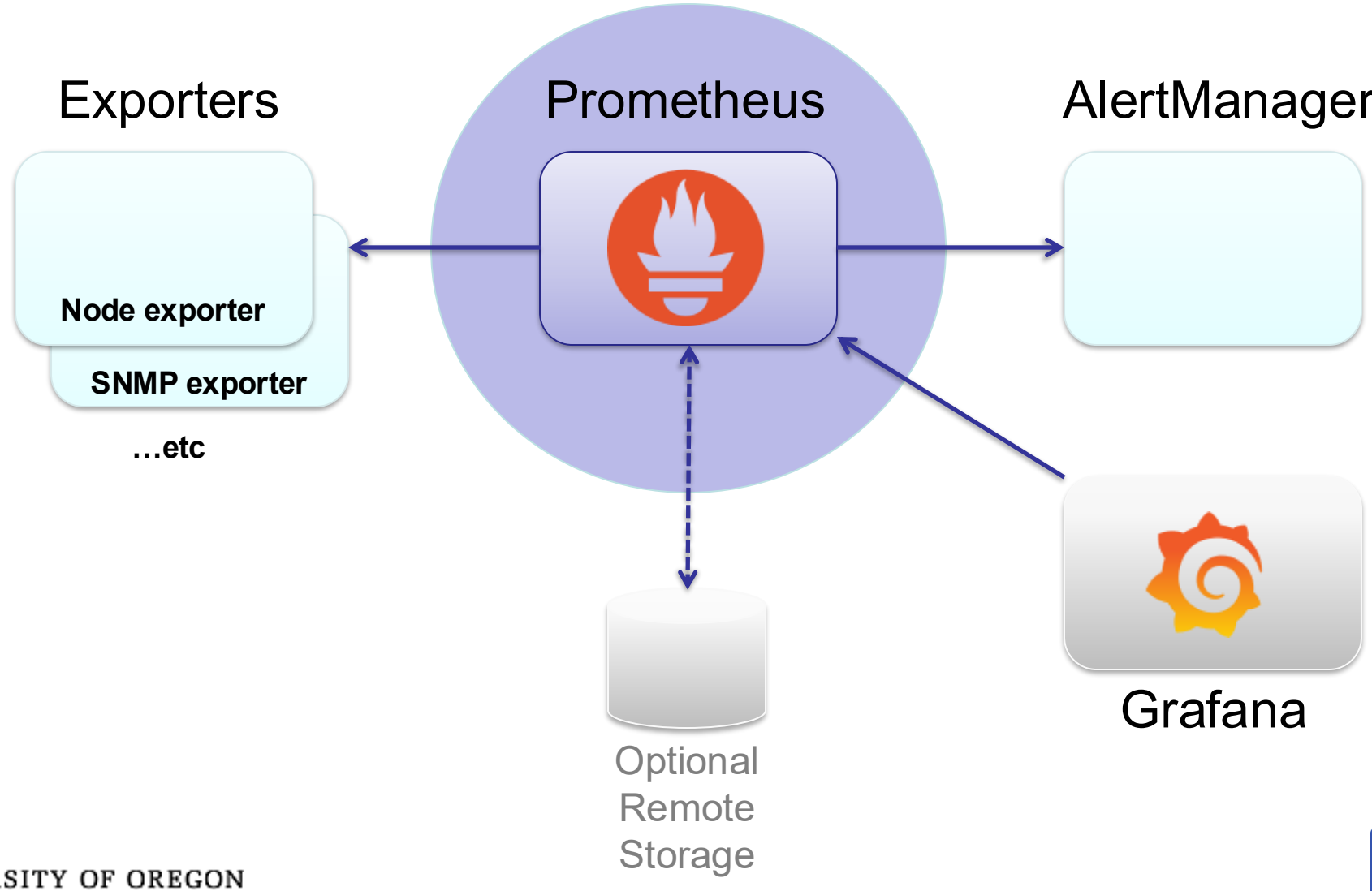
- Released in 1999, designed to minimize **disk space usage**
  - Hard disks are now 1,000 times bigger, but IOPS only slightly better
  - It's now solving the wrong problem
- Reduces resolution (throws data away) to maintain fixed file sizes
- Updates often rewrite the whole file
  - Very inefficient, and very bad for write amplification on SSDs
  - *rrdcached* tries to help
- You need to throw a lot of hardware at the problem
- A new generation of **time series databases** (TSDB) are much better optimized for this use case

InfluxDB, Cassandra, TimescaleDB, VictoriaMetrics, OpenTSDB, Clickhouse, Yottadb…

What's Prometheus?

- Highly efficient time series database
  - Average usage: 1.7 bytes per data point
  - Batched writes and Write-Ahead Log minimize I/O
- Data collection engine (scraper)
- Query language (PromQL)
- Alerting rules engine
- HTTP API and web query frontend
- Metrics exchange format (OpenMetrics)
- Sounds like what we want!

Prometheus ecosystem



Data collection

- Prometheus' background is from devops (think: kubernetes)
- Data collection is by making periodic HTTP requests to "exporters"
  - Active polling, a.k.a. "pull monitoring"
  - Can proxy it, enable TLS and authentication, etc
- HTTP response in *OpenMetrics* format
  - Plain text: easy to read, easy to debug (e.g. with curl)

```
curl -fsS localhost:9100/metrics
…
node_filesystem_avail_bytes{device="/dev/mapper/vg0-root",fstype="ext4",mountpoint="/"} 7.27789568e+09
node_filesystem_avail_bytes{device="/dev/nvme0n1p1",fstype="vfat",mountpoint="/boot/efi"} 1.1186176e+09
node_filesystem_avail_bytes{device="lxcfs",fstype="fuse.lxcfs",mountpoint="/var/lib/incus-lxcfs"} 0
…
```

Example exporters

- **node_exporter** collects *nix server stats - snmpd not needed
  - very easy to add custom metrics (textfile collector)
- **windows_exporter** for Windows servers
- **blackbox_exporter** performs Nagios-like active service checks
- Third-party exporters for Postgres, IPMI, LVM, Proxmox VE, …
- Built-in prometheus exporters in many modern applications
  - e.g. ceph, linstor, incus, netbox, zrepl, powerdns, …

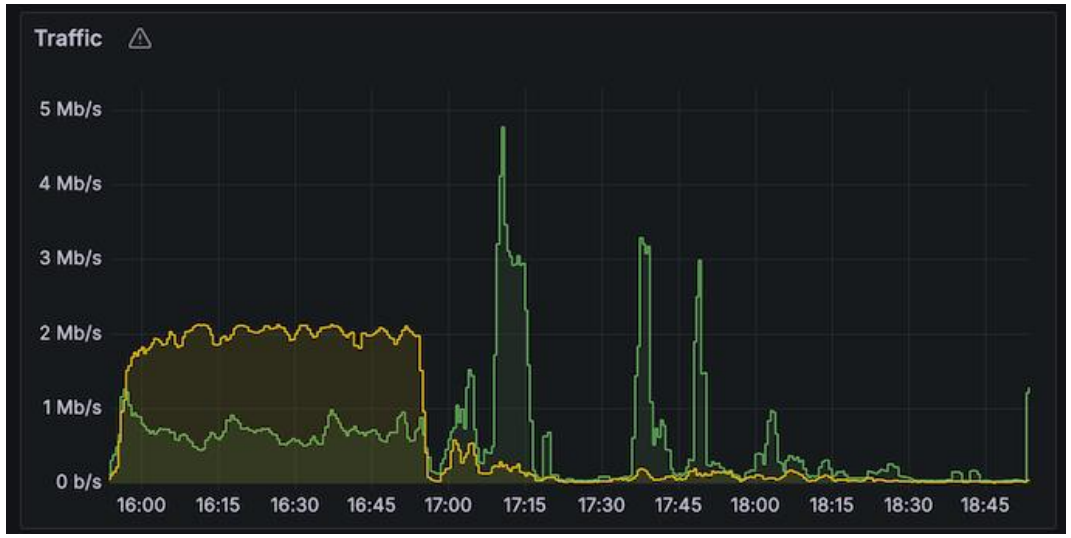
But can you use it with SNMP?

- Yes!
- Pull-mode maps nicely to SNMP polling
- **snmp_exporter** accepts HTTP scrape request, performs SNMP collection, and returns OpenMetrics

```
ifHCInOctets{instance="rtr1",ifName="gi0"} 1.7658225527e+10
ifHCInOctets{instance="rtr1",ifName="gi1"} 3.56567063e+08
ifHCOutOctets{instance="rtr1",ifName="gi0"} 3.56567063e+08
ifHCOutOctets{instance="rtr1",ifName="gi1"} 2.5711868714e+10
```

Does it work?

- Yes! Incredibly well
- In my experience, you can scrape at 1 minute intervals instead of 5 minutes, and still use around **1%** of the resources of LibreNMS! *



* Collecting only IF_MIB. Maybe unfair comparison, LibreNMS was likely collecting more MIBs

What's the catch? Rather a lot, actually.

- It's not a Network Management System, it's a kit of parts!
  - With a steep learning curve
- There's no built-in network inventory or device auto-discovery
  - It can read various types of inventory, from YAML files to cloud APIs; Prometheus calls these modules "service discovery"
  - Inventory needs to specify scrape options, e.g. explicitly which MIB(s) to poll for each SNMP device

What's the catch? (cont'd)

- SNMP collection is tricky to configure at first
  - Need "relabeling rules" to set HTTP parameters for each scrape, e.g.

```
localhost:9116/snmp?target=10.12.255.1&module=if_mib&auth=workshop_v3
```

- To use MIBs other than the supplied ones, you have to compile them into YAML using the "generator", which is also tricky
  - Compile Go code from source; isolate all the MIB interdependencies

What's the catch? (cont'd 2)

- PromQL is not like any other query language you've used
  - A key part of the learning curve
  - It works with "vectors" of values, distinguished by "labels"
  - But it's very powerful, and the same language is used for dashboards, configuring alerts (inc. using history), and ad-hoc queries

PromQL query examples

- All values of a given metric name

```
node_filesystem_avail_bytes
```

- Filter by label values or patterns

```
node_filesystem_avail_bytes{mountpoint="/home"}
node_filesystem_avail_bytes{instance=~"server[1-3]"}
```

- Filter by time series value

```
node_filesystem_avail_bytes < 100000000
```

  - Commonly used for alerting expressions
  - Note that this is not a boolean (true/false) result: it filters out values which don't meet the criteria, and passes those that do
  - If *any* value is present in the result set, an alert is fired

More query examples

- Arithmetic

  ```
  node_filesystem_avail_bytes / 1024
  node_filesystem_avail_bytes / node_filesystem_size_bytes
  ```

- Functions across time series

  ```
  sum(node_filesystem_avail_bytes)
  ```

  Returns a 1-element instant vector with the *total available size*

  ```
  min(node_filesystem_avail_bytes)
  ```

  Returns a 1-element instant vector with the *lowest available size*

- Turning counters into rates

  ```
  rate(ifHCInOctets[5m])
  ```

What's the catch? (cont'd 3)

- In many ways, you're starting from scratch for network monitoring
  - No pre-existing Grafana dashboards for SNMP *
  - No pre-existing alerting rules for common conditions, like "disk full"
- More discussion:
  - https://docs.google.com/document/d/1oEpjiWfTHF352NCAOGolwij3EIkrprCkdQmaQMpjg4M/ *"First-class network monitoring support in the Prometheus & Grafana ecosystem"*

* I published dashboards #12489 and #12492 as examples

Note: Prometheus is for metrics only

- For logs and netflow you'll need something else
  - Elasticsearch/Opensearch – *resource hungry*
  - Grafana Loki
  - VictoriaLogs
  - ClickHouse (+ OTel Collector, Akvorado, ntop-ng …)
  - OpenObserve
  - Quickwit
  - …
- But you *can* generate metrics from logs
  - e.g. counts of errors, histograms of response times

Bottom line: should you deploy this for NM?

- Yes, if…
- you have large numbers of network devices to poll (CPE, IOT); or
- you have non-SNMP metrics to collect too (e.g. application monitoring); or
- you have in-house systems or dev expertise