

# Workshop Monitoring with Prometheus and Grafana

To walk through the steps in these handson instructions, you need an environment with Prometheus, Grafana and Docker Engine. This document describes two approaches that both require Virtual Box on your laptop:

1. Use the fully prepared Virtual Machine

Just import the *.ova* file into Virtual Box, run the machine and login with vagrant/vagrant

2. Create and run the environment ‘from scratch’ using Vagrant; then connect using ssh

You need to pick one of these two approaches.

Quick online handson

A third option is to run a Prometheus handson completely in the cloud, at

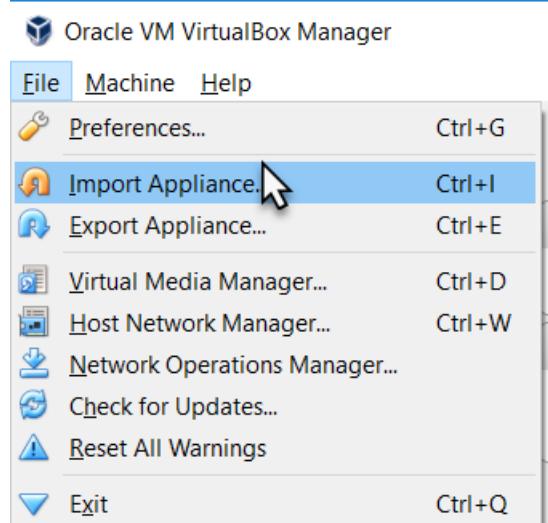
<https://www.katacoda.com/courses/prometheus/getting-started> (at Katacoda, a Prometheus instance is spun up for you in the cloud and you can walk through the basic steps of scraping the Node Exporter).

## Use the fully prepared Virtual Machine

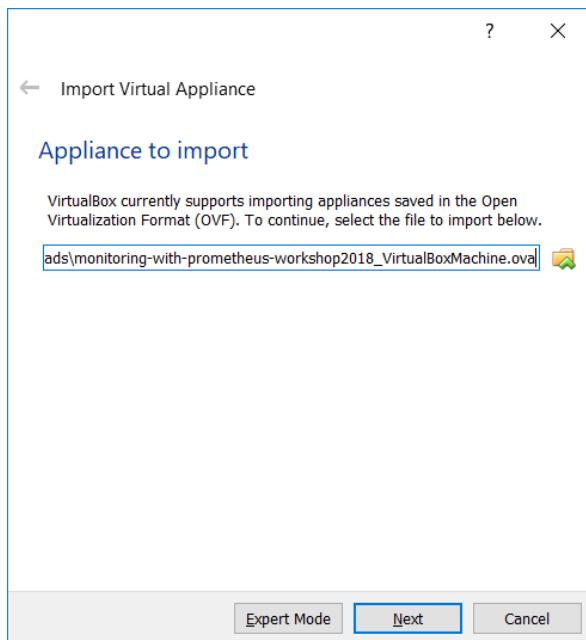
Download the Virtual Machine from this URL: [One Drive - monitoring-with-prometheus-workshop2018\\_VirtualBoxMachine.ova](https://One%20Drive%20-%20monitoring-with-prometheus-workshop2018_VirtualBoxMachine.ova) - or copy it from the USB drive handed to you by the workshop instructor.

Run VirtualBox.

Open the File menu and select Import Appliance

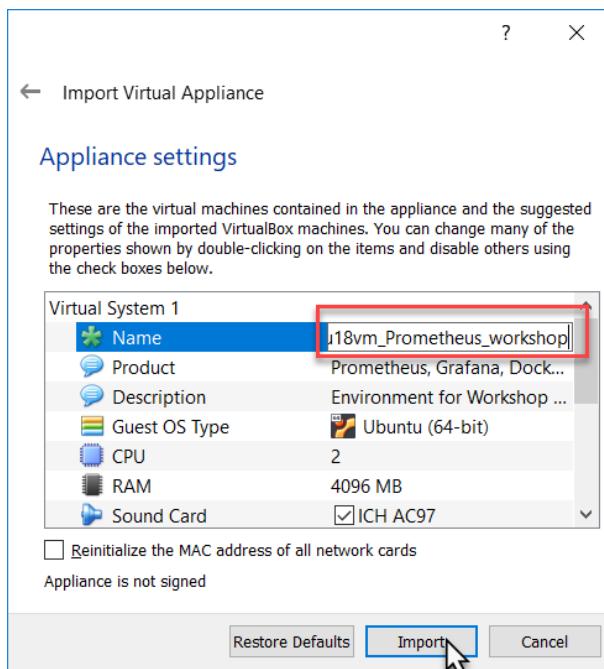


Browse for the ova file monitoring-with-prometheus-workshop2018\_VirtualBoxMachine.ova



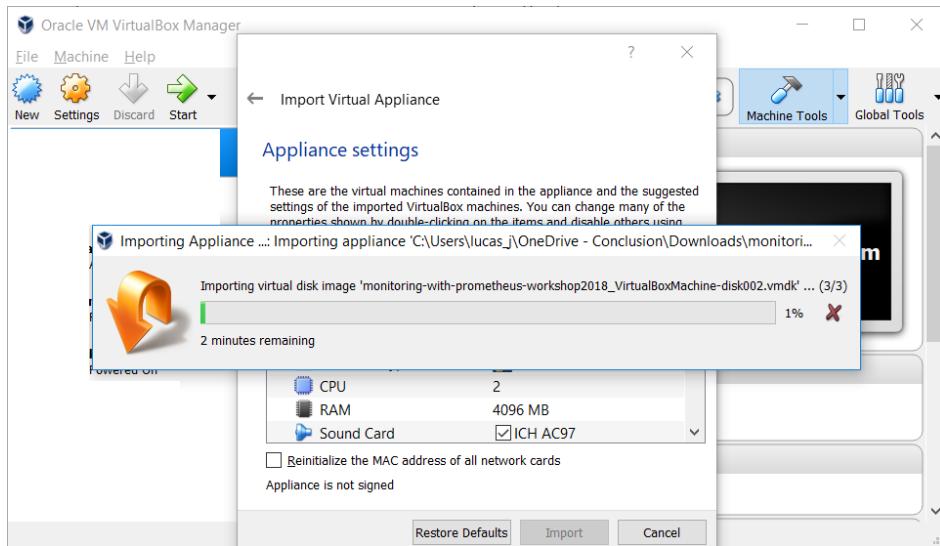
And press Next.

You may want to edit the title or any of the other properties – although the current settings will do nicely.

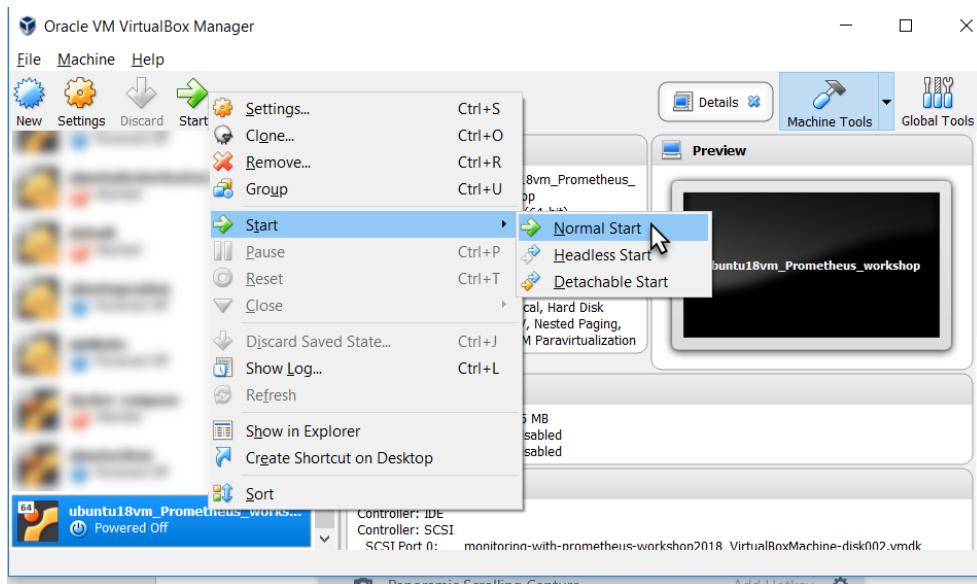


Press Import to do import the appliance.

The appliance is imported. This will take a few minutes.



After the appliance is loaded, either double click on it or use the *Start* option context menu .



When the VM is running,

Login as vagrant/vagrant

```
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/advantage

System information as of Tue Sep 11 12:18:34 UTC 2018

System load: 0.73      Processes:          98
Usage of /: 6.3% of 48.41GB  Users logged in:    0
Memory usage: 4%
Swap usage:  0%          IP address for enp0s8: 192.168.188.112
                           IP address for docker0: 172.17.0.1

Get cloud support with Ubuntu Advantage Cloud Guest:
http://www.ubuntu.com/business/services/cloud

* Canonical Livepatch is available for installation.
- Reduce system reboots and improve kernel security. Activate at:
https://ubuntu.com/livepatch

0 packages can be updated.
0 updates are security updates.

vagrant@ubuntu-bionic:~$
```

You can skip the next section and turn to the section titled First Run Prometheus.

Note:

You can start (multiple) programs in background using the

`nohup <command> &`

construction.

For example:

`nohup ./prometheus &`

To stop a background job, use

`ps -ef | grep <string identifying the job>`

to learn the process id of the job and then use

`kill <job_id>`

to stop the background job.

## Create the environment from scratch

Note: in order to successfully complete these steps, you need to have both VirtualBox (<https://www.virtualbox.org/wiki/Downloads>) and Vagrant (<https://www.vagrantup.com/downloads.html>) installed on your laptop.

Clone GitHub Repo <https://github.com/lucasjellema/monitoring-workshop-prometheus-grafana> to your laptop.

### Create Virtual Machine using Vagrant

Open a command line (or terminal) window and navigate to the root directory of the cloned repository. Then run:

```
vagrant plugin install vagrant-disksize
```

This installs a plugin for Vagrant that allows us to specify the disksize of the VMs produced by Vagrant. Then execute:

```
vagrant up
```

This will create and run a Virtual Machine, accessible at IP address 192.168.188.112 and with Ubuntu 18 LTS (Bionic – see <https://wiki.ubuntu.com/BionicBeaver/ReleaseNotes> for release notes) and Docker Engine set up. This step will take several minutes.

Next, run:

```
vagrant ssh
```

This will connect you to the Virtual Machine, as user vagrant.

### Download resources

First the Prometheus server. Execute this command:

```
wget  
https://github.com/prometheus/prometheus/releases/download/v2.3.2/prometheus-2.3.2.linux-amd64.tar.gz
```

to download the Prometheus server. Then extract the archive using:

```
tar -xzf prometheus-2.3.2.linux-amd64.tar.gz
```

Then download the alertmanager – a standalone component:

```
wget  
https://github.com/prometheus/alertmanager/releases/download/v0.15.2/alertmanager-0.15.2.linux-amd64.tar.gz
```

That also needs to be extracted:

```
tar xvfz alertmanager-0.15.2.linux-amd64.tar.gz
```

At this point, all required resources have been added to the Virtual Machine and you are ready to proceed.

## First Run Prometheus

Prometheus is ready to run. It has a minimal configuration at this point – in the `prometheus.yml` file in directory `~/prometheus-2.3.2.linux-amd64`. This file has one scrape-config entry called `prometheus` – one that instructs Prometheus to scrape itself – at port 9090. The application Prometheus exposes metrics for monitoring purposes – to allow administrators to observe the behaviour and health of the Prometheus platform. Prometheus – the same or a different instance – can be used to gather and analyse these metrics.

Navigate to the home directory for Prometheus:

```
cd prometheus-2.3.2.linux-amd64/
```

And list the files

```
ls
```

You should see the `prometheus.yml` file. Use

```
cat prometheus.yml
```

to inspect the contents of the file. You should find the scrape config for `prometheus` itself.

Start Prometheus:

```
./prometheus
```

This will bring up the Prometheus server that will load and interpret the `prometheus.yml` configuration file and start acting according to its contents. This means that Prometheus starts scraping the metrics exposed by Prometheus itself.

Open a browser window on your laptop for the URL <http://192.168.188.112:9090/targets> . This will show a page with all the scrape targets currently configured for this Prometheus instance. There will be only one target shown – Prometheus itself.

The metrics that Prometheus exposes can be inspected in their raw form at <http://192.168.188.112:9090/metrics> . Here you will see the metrics that the developers of the Prometheus platform have decided to expose in order to optimize the observability of their platform.

A more pleasing presentation of these same metrics – after scraping and processing by Prometheus – can be seen at <http://192.168.188.112:9090/graph> .

Check for example the metric `prometheus_http_request_duration_seconds_count` - the running count for the number of measurements of the latency for HTTP requests.

Prometheus    Alerts    Graph    Status ▾    Help

Enable query history

`prometheus_http_request_duration_seconds_count`

Execute    prometheus\_http\_request\_ ▾

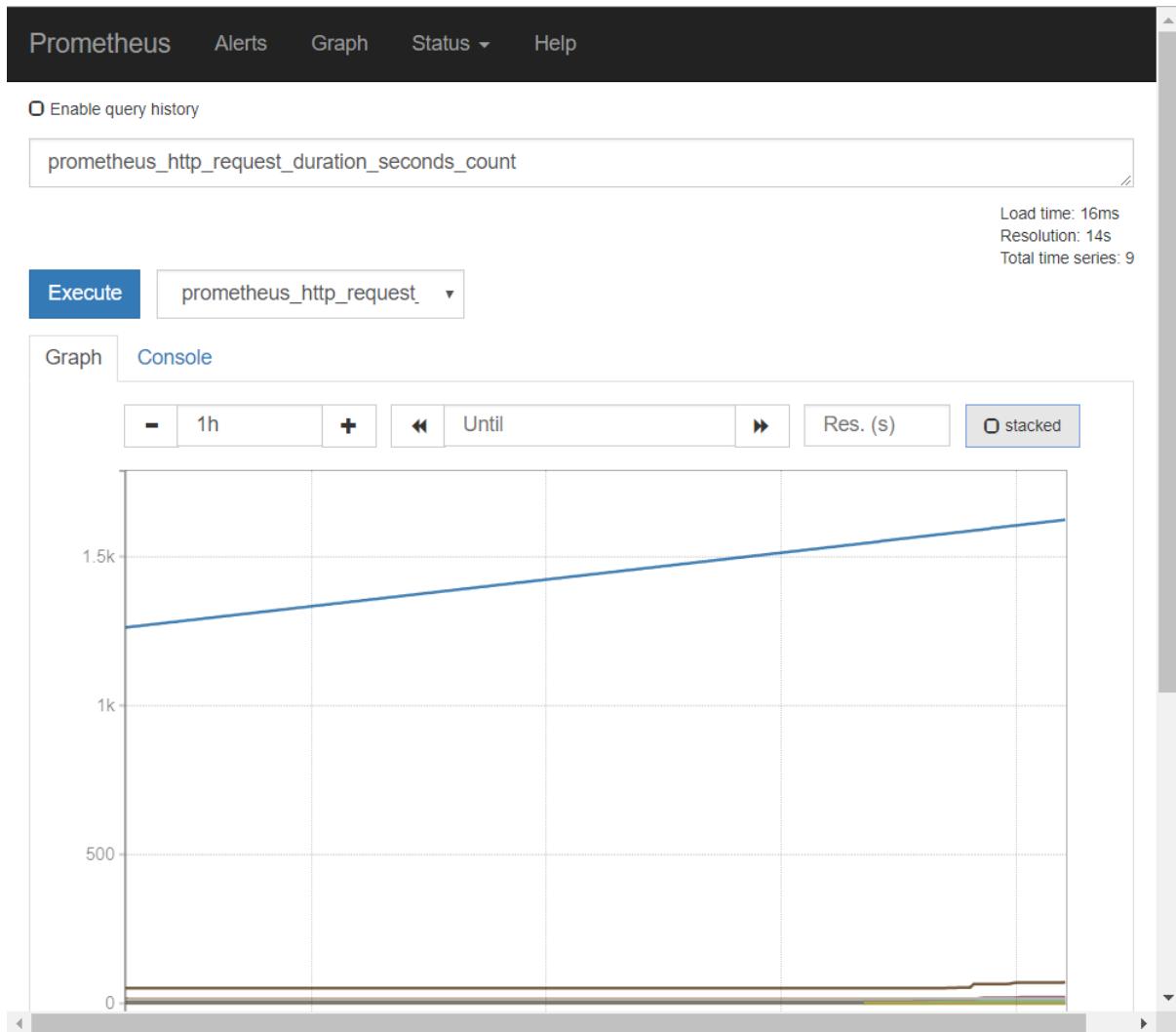
Graph    Console

Element	Value
prometheus_http_request_duration_seconds_count{handler="/alerts",instance="localhost:9090",job="prometheus"}	14
prometheus_http_request_duration_seconds_count{handler="/graph",instance="localhost:9090",job="prometheus"}	7
prometheus_http_request_duration_seconds_count{handler="/label/name/values",instance="localhost:9090",job="prometheus"}	10
prometheus_http_request_duration_seconds_count{handler="/metrics",instance="localhost:9090",job="prometheus"}	1606
prometheus_http_request_duration_seconds_count{handler="/query",instance="localhost:9090",job="prometheus"}	20
prometheus_http_request_duration_seconds_count{handler="/query_range",instance="localhost:9090",job="prometheus"}	70
prometheus_http_request_duration_seconds_count{handler="/rules",instance="localhost:9090",job="prometheus"}	1
prometheus_http_request_duration_seconds_count{handler="/static/filepath",instance="localhost:9090",job="prometheus"}	16
prometheus_http_request_duration_seconds_count{handler="/targets",instance="localhost:9090",job="prometheus"}	1

Remove Graph

Add Graph

Toggle to the Graph tab to see the evolution over time for this metric – for each of the label combinations. At this point, only the *handler* label has different values for this metric.



Feel free to explore some of the other metrics published by Prometheus – although I fear most are only meaningful to Prometheus experts.

At <http://192.168.188.112:9090/config> you can inspect the contents of the `prometheus.yml` configuration file.

## Configuration

```
global:
  scrape_interval: 15s
  scrape_timeout: 10s
  evaluation_interval: 15s
alerting:
  alertmanagers:
    - static_configs:
      - targets: []
        scheme: http
        timeout: 10s
scrape_configs:
  - job_name: prometheus
    scrape_interval: 15s
    scrape_timeout: 10s
    metrics_path: /metrics
    scheme: http
    static_configs:
      - targets:
          - localhost:9090
```

At <http://192.168.188.112:9090/status> you will see details on this instance of Prometheus - exact version, current runtime status etc.

Stop Prometheus for now – simply by typing CTRL+C in the command line window.

## Make Prometheus scrape Linux server metrics

It is of limited interest at this point to be looking with Prometheus at how Prometheus is doing. More interesting is to monitor a more pressing component, say our Linux server. The Linux operating system sits on any many status indicators and operational metrics – but does not expose them out of the box in a format that Prometheus understands.

The Node Exporter is a component that acts as the adapter between the Linux operating system and Prometheus. When the Node Exporter is running on a Linux system, it exposes an HTTP endpoint (by default this will be /metrics on port 9100) where Prometheus can come to collect all available metrics. It exposes machine-level metrics, largely from your operating system's kernel, such as CPU, memory, disk space, disk I/O, network bandwidth, and motherboard temperature.

Let's monitor the Virtual Machine using Prometheus. First, let's run Node Exporter in a Docker container (in order to scrape metrics for the Linux system):

```
docker run -d -p 9100:9100 -v "/proc:/host/proc" -v "/sys:/host/sys" -v
"/:/rootfs" --net="host" --name=prometheus quay.io/prometheus/node-
exporter:v0.13.0 -collector.procfs /host/proc -collector.sysfs /host/sys
-collector.filesystem.ignored-mount-points
"^(sys|proc|dev|host|etc)(/$|/)"
```

You can check with `docker ps` that the node\_exporter container is indeed running in the background.

In the browser on the laptop host machine, navigate to

<http://192.168.188.112:9100/metrics>

This is the endpoint at which the Prometheus Node exporter for Linux publishes its metrics – for Prometheus to scrape. If we can see the raw metrics at this end point, we can now proceed to configure our Prometheus instance to start scraping these metrics.

Return to the command line in the VM. Change directory to `~/prometheus-2.3.2.linux-amd64`.

Edit the configuration file `prometheus.yml`. Add the following snippet under `scrape-configs`:

```
- job_name: linux-server-node
  static_configs:
    - targets:
      - localhost:9100
```

This entry instructs Prometheus to start scraping metrics from the endpoint `localhost:9100/metrics` – using the global time interval (since no specific interval is specified for this job). This endpoint – as we have seen for ourselves – is the endpoint where the `node_exporter` publishes the Linux metrics for the Linux host on which Prometheus is running.

Now start Prometheus Server

```
./prometheus
```

In the browser on your laptop, navigate to <http://192.168.188.112:9090/targets>. You will see the targets from which your Prometheus instance is scraping metrics. In addition to Prometheus target that we saw before, we now also should see the linux-server-node.

Open the Graph tab – or navigate to <http://192.168.188.112:9090/graph>. Open the dropdown next to the Execute button. You will now see a list of all the metrics currently available in the metrics store of your Prometheus instance.

The screenshot shows the Prometheus web interface with the 'Graph' tab selected. At the top, there's a navigation bar with links for Prometheus, Alerts, Graph, Status, and Help. Below the navigation bar, there's a checkbox labeled 'Enable query history'. The main area has a search input field and a dropdown menu. The 'Execute' button is highlighted in blue. To its right is a dropdown menu containing a list of metrics. The list includes various network statistics such as node\_netstat\_TcpExt\_ListenerOverflows, node\_netstat\_TcpExt\_SyncookiesFailed, etc., down to node\_network\_receive\_bytes\_total, which is highlighted with a blue selection bar at the bottom of the list.

Select the metric called *node\_network\_receive\_bytes* or *node\_network\_receive\_bytes\_total* and press Execute.

This will list the total number bytes received over each of the network devices for the Linux server in the VM.

Prometheus    Alerts    Graph    Status ▾    Help

Enable query history

node\_network\_receive\_bytes\_total

Load time: 12ms  
Resolution: 3s  
Total time series: 4

Execute    node\_network\_receive\_by ▾

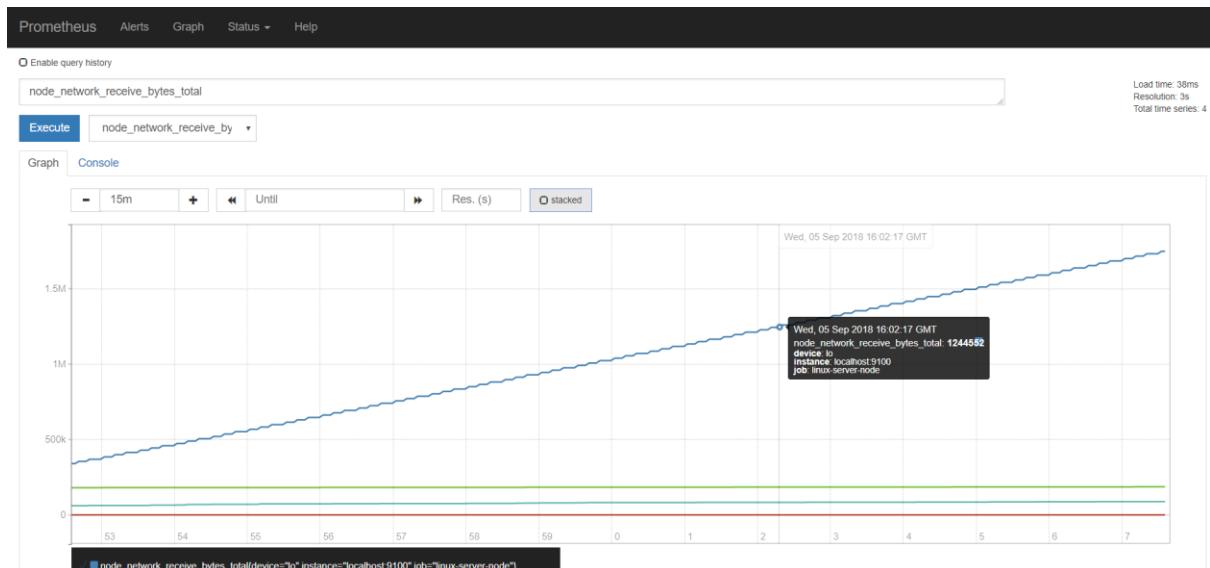
Graph    Console

Element	Value
node_network_receive_bytes_total{device="docker0",instance="localhost:9100",job="linux-server-node"}	0
node_network_receive_bytes_total{device="enp0s3",instance="localhost:9100",job="linux-server-node"}	185726
node_network_receive_bytes_total{device="enp0s8",instance="localhost:9100",job="linux-server-node"}	85960
node_network_receive_bytes_total{device="lo",instance="localhost:9100",job="linux-server-node"}	1575486

Remove Graph

Add Graph

Press Graph to get a graphical representation of these values and their evolution over time:



Using wget to download some additional files should have an effect on this metric.

Feel free to inspect some of the other metrics available from the Linux system – such as

- node\_cpu\_seconds\_total (a counter indicating how much time each CPU spent in each mode)
- node\_filesystem\_size\_bytes and node\_filesystem\_avail\_bytes (gauges indicating the total filesystem size and the available sizes).
- node\_memory\_MemFree\_bytes - the amount of memory that isn't used by anything

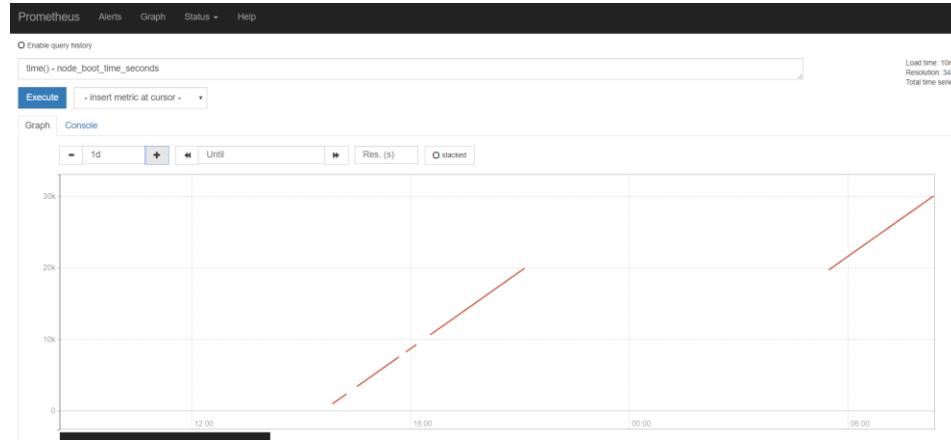
## Quick intro to PromQL

In addition to inspecting and visualizing the values of metrics, the Prometheus Web UI also allows us to use PromQL – the Prometheus query language. This allows us to perform calculations with metrics – resulting in more meaningful values than just the bare metrics themselves.

For example, enter the following PromQL expression in the input field

```
time() - node_boot_time_seconds
```

and press execute. The resulting value is how long the kernel has been up. The result of an expression can both be presented in tabular format and as a graph.



Try this expression

```
rate(node_network_receive_bytes_total[1m])
```

It tells you about the bandwidth used up by each network device – by calculating the change rate in the total number of bytes received. Do another wget operation to create some network traffic.

And :

```
avg without(cpu, mode)(rate(node_cpu_seconds_total{mode="idle"}[1m]))
```

the proportion of idle time across all CPUs . This works as it calculates the idle time per second per CPU and then averages that across all the CPUs in the machine.

If you want to know the proportion of idle time for each CPU, then remove cpu from the without expression:

```
avg without( mode)(rate(node_cpu_seconds_total{mode="idle"}[1m]))
```

See <https://prometheus.io/docs/prometheus/latest/querying/basics/> for more details on PromQL and the operators and functions at our disposal.

See <https://prometheus.io/docs/guides/node-exporter/> for details on the Node Exporter and all metrics it exposes.

## MySQL Exporter

To give you a taste of what using Exporters for third party applications and platform components looks like, we will now run a MySQL server instance in a Docker container, then attach a MySQL Exporter for Prometheus to this instance and scrape the MySQL metrics in our Prometheus server.

On the command line in the VM, stop Prometheus. Then, to run the MySQL server instance, execute this command:

```
docker run --name mysql-db -e MYSQL_ROOT_PASSWORD=my-secret -d mysql:8
```

Note: this will cause quite some network traffic - if you started with a fresh image using Vagrant-- which you can easily verify in the Prometheus Console later on by inspecting the metric *node\_network\_receive\_bytes\_total*.

Note: you could connect to this MySQL instance using this command – but for the purpose of these practice steps you do not have to:

```
docker run -it --link mysql-db:mysql --rm mysql sh -c 'exec mysql -h"$MYSQL_PORT_3306_TCP_ADDR" -P"$MYSQL_PORT_3306_TCP_PORT" -uroot -p"my-secret"'
```

and execute MySQL command line statements such as:

```
show databases;
```

Next, run the Prometheus Exporter for MySQL, in its own Docker container:

```
docker run --name mysql-exporter -d \
-p 9104:9104 \
--link mysql-db:mysql \
-e DATA_SOURCE_NAME="root:my-secret@(mysql:3306)://" \
prom/mysqld-exporter
```

To make the Prometheus server scrape the metrics from the MySQL Exporter, we have to add the following entry to the `prometheus.yml` file:

```
- job_name: 'mysqld'
  static_configs:
    - targets:
      - localhost:9104
```

This instructs Prometheus to check the `/metrics` endpoint at port 9104 on the localhost – which is mapped to port 9104 in the container running the MySQL Exporter.

Note: Prometheus can reload the configuration file while it continues to run; you have to send a POST request to the `/-/reload` endpoint. Alternatively, when you restart Prometheus it will of course also pick up the changes in the `prometheus.yml` file.

After restarting the Prometheus server, you will find that MySQL has been added as a target:

The screenshot shows the Prometheus UI's "Targets" page. It lists three targets:

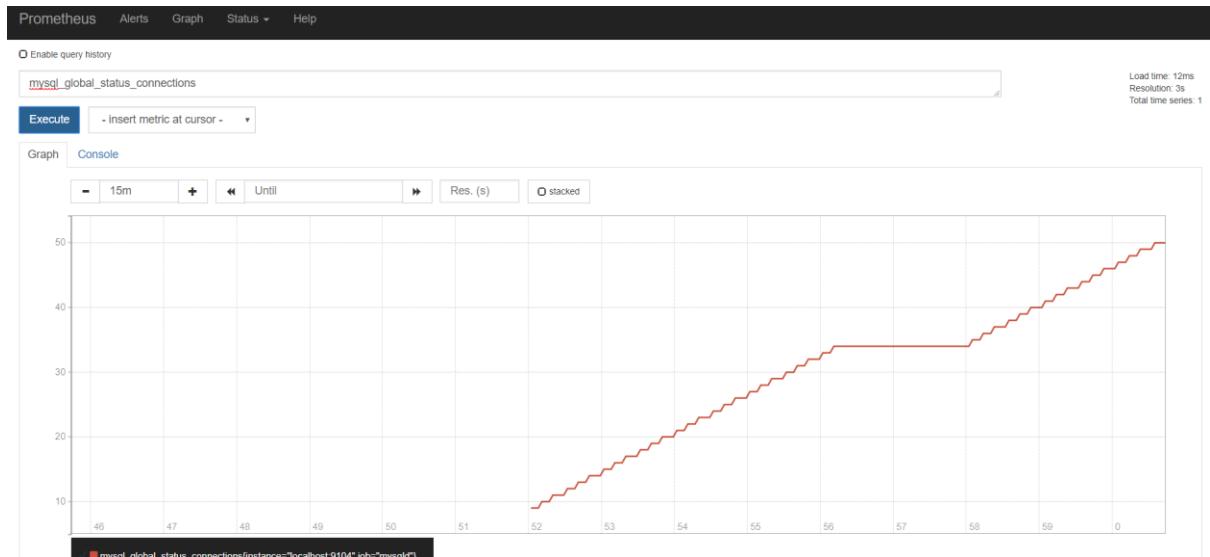
- linux-server-node (1/1 up)**: Shows one endpoint `http://localhost:9100/metrics` in UP state, last scraped 9.218s ago.
- mysqld (1/1 up)**: Shows one endpoint `http://localhost:9104/metrics` in UP state, last scraped 8.383s ago. This row is highlighted with a red box.
- nodejs-example-application (1/1 up)**: Shows one endpoint `http://127.0.0.1:3001/metrics` in UP state, last scraped 1.92s ago.
- prometheus (1/1 up)**: Shows one endpoint `http://localhost:9090/metrics` in UP state, last scraped 4.821s ago.

And that now MySQL Metrics are available in the Prometheus UI.

The screenshot shows the Prometheus UI's "Metrics" page for the `mysqld` target. The search bar contains `mysql`. The results list various MySQL metrics:

- mysql\_exporter\_collector\_duration\_seconds**
- `mysql_exporter_last_scrape_error`
- `mysql_exporter_scrapes_total`
- `mysql_global_status_aborted_clients`
- `mysql_global_status_aborted_connects`
- `mysql_global_status_acl_cache_items_count`
- `mysql_global_status_binlog_cache_disk_use`
- `mysql_global_status_binlog_cache_use`
- `mysql_global_status_binlog_stmt_cache_disk_use`
- `mysql_global_status_binlog_stmt_cache_use`
- `mysql_global_status_buffer_pool_page_changes_total`
- `mysql_global_status_buffer_pool_pages`
- `mysql_global_status_bytes_received`
- `mysql_global_status_bytes_sent`
- `mysql_global_status_commands_total`
- `mysql_global_status_connection_errors_total`
- `mysql_global_status_connections`
- `mysql_global_status_created_tmp_disk_tables`
- `mysql_global_status_created_tmp_files`
- `mysql_global_status_created_tmp_tables`
- `mysql_global_status_delayed_errors`
- `mysql_global_status_delayed_insert_threads`

Check for example the number of connections:



It seems that all these connections are created for the MySQL exporter itself. Some tuning may be in order.

On the command line in the VM, stop the Docker container with the MySQL Exporter.

```
docker stop mysql-exporter
```

Now check on the targets page in the Prometheus UI:

Prometheus Alerts Graph Status Help

### Targets

All Unhealthy

**linux-server-node (1/1 up)** show less

Endpoint	State	Labels	Last Scrape	Error
http://localhost:9100/metrics	UP	instance="localhost:9100"	5.058s ago	

**mysqld (0/1 up)** show less

Endpoint	State	Labels	Last Scrape	Error
http://localhost:9104/metrics	DOWN	instance="localhost:9104"	4.212s ago	Get http://localhost:9104/metrics: dial tcp 127.0.0.1:9104: connect: connection refused

**nodejs-example-application (1/1 up)** show less

Endpoint	State	Labels	Last Scrape	Error
http://127.0.0.1:3001/metrics	UP	instance="127.0.0.1:3001"	2.751s ago	

**prometheus (1/1 up)** show less

Endpoint	State	Labels	Last Scrape	Error
http://localhost:9090/metrics	UP	instance="localhost:9090"	654ms ago	

It should be obvious that the MySQL target is no longer available.

When you check under Alerts, you will find no alerts – because none have been configured yet.

## Application Specific metrics from a NodeJS application

Prometheus can be used to monitor any metric – produced by any type of component.

Infrastructure components – such as Linux servers – and platform components such as Databases and Messaging Systems – are commonly monitored. Even more important is monitoring business applications for the aspects that really matter to end users. For that to happen, metrics that are indicative of those aspects should be exposed by the business applications.

Developers creating business applications should make sure that meaningful, functional metrics are exposed by their application. Generic exporters generally not be able to extract metrics that translate directly into meaningful business indicators. Prometheus Client Libraries are available for all prominent programming languages. Using such libraries, it becomes straightforward to add metric exposing capabilities to an application. Note: defining what those metrics should be is still the responsibility of the DevOps team.

We will now take a look at a simple Node JS application that has been instrumented: it exposes application specific metrics that are deemed relevant for observing application behaviour.

Additionally, the client libraries expose generic metrics for their specific runtime technology stack.

First you need to install Node JS – if it is not already set up in your VM (you can check this by executing "node --version"). To install Node JS, execute

```
sudo apt install nodejs
```

Answer yes when asked 'Do you want to continue?' during the package installation.

Do the same for NPM:

```
sudo apt install npm
```

Note: this will take considerable time, probably several minutes.

If you now execute

```
node --version
```

you should get the version label for the installed version of the Node JS runtime.

And with

```
npm --version
```

you should get the version label for the installed version of the NPM runtime.

From the command line, navigate to the user's home directory.

```
cd ~
```

Then clone a GitHub repo:

```
git clone https://github.com/lucasjellema/example-prometheus-nodejs
```

This will copy the sources of an instrumented NodeJS application to the VM.

Navigate into the directory *example-prometheus-nodejs* and execute

```
npm install
```

to install the library dependencies for this application.

Inspect the source code of the Node application at this URL:

<https://github.com/lucasjellema/example-prometheus-nodejs/blob/master/src/server.js>. You will see how the /metrics endpoint is exposed and how GET requests are handled by Prometheus.register.metrics(). This generic function returns the proper Prometheus format – and injects all generic NodeJS metrics as well as all application specific metrics: *checkoutsTotal* and *httpRequestDurationMicroseconds*.

Run the NodeJS application using

```
nohup npm start &
```

You can now access the NodeJS application at <http://192.168.188.112:3001/> and invoke its most special functionality at: http://192.168.188.112:3001/checkout . This resource will return a payment\_method; a Prometheus counter metric keeps track of the number of instances for each payment\_method.

Note: a query parameter *payment\_method* can be added to the URL request – to force a specific payment\_method, like this:

[http://192.168.188.112:3001/checkout?payment\\_method=cash](http://192.168.188.112:3001/checkout?payment_method=cash)

Every payment\_method you introduce will result in additional metric values – for the payment\_method label value.

The Prometheus metrics exposed by the application – through the use of the NodeJS Client Library - can be read at: <http://192.168.188.112:3001/metrics>. The custom – application specific – metrics can be found at the bottom of the document. See documentation on prom-client - <https://www.npmjs.com/package/prom-client> - for details on the standard metrics.

In order to make Prometheus scrape the metrics from the NodeJS example application, you should add another scrape-job in the prometheus.yml file:

```
- job_name: nodejs-example-application
  scrape_interval: 5s
  static_configs:
    - targets:
      - 127.0.0.1:3001
```

Restart the Prometheus server – or: have the configuration file reloaded by sending a HTTP POST to the */-/reload* endpoint:

```
curl -X POST http://localhost:9090/-/reload
```

Note: this reload action is only allowed if the Prometheus server has been started with this flag:

```
--web.enable-lifecycle
```

Verify if the NodeJS Example application is now added as a target :

<http://192.168.188.112:9090/targets>

Prometheus    Alerts    Graph    Status ▾    Help

## Targets

All    Unhealthy

linux-server-node (1/1 up) show less

Endpoint	State	Labels	Last Scrape	Error
http://localhost:9100/metrics	UP	instance="localhost:9100"	7.381s ago	

nodejs-example-application (1/1 up) show less

Endpoint	State	Labels	Last Scrape	Error
http://127.0.0.1:3001/metrics	UP	instance="127.0.0.1:3001"	73ms ago	

prometheus (1/1 up) show less

Endpoint	State	Labels	Last Scrape	Error
http://localhost:9090/metrics	UP	instance="localhost:9090"	2.976s ago	

Go to the graph tab. Type *check* in the input field. The auto suggest option should now list *checkouts\_total* as a metric available for inspection. This is one of the two custom metrics defined in the NodeJS application, through the Prometheus Client Application for NodeJS .

Prometheus    Alerts    Graph    Status ▾    Help

Enable query history

check

checkouts\_total

prometheus\_tsdb\_compaction\_chunk\_range\_bucket  
prometheus\_tsdb\_compaction\_chunk\_samples\_bucket  
prometheus\_tsdb\_compaction\_chunk\_size\_bucket

no data

Add Graph

Select *checkouts\_total* and press the Execute button:

Prometheus    Alerts    Graph    Status ▾    Help

Enable query history

checkouts\_total

Load time: 11ms  
Resolution: 14s  
Total time series: 2

**Execute**    - insert metric at cursor - ▾

**Graph**    Console

Element	Value
checkouts_total{instance="127.0.0.1:3001",job="nodejs-example-application",payment_method="paypal"}	4
checkouts_total{instance="127.0.0.1:3001",job="nodejs-example-application",payment_method="stripe"}	5

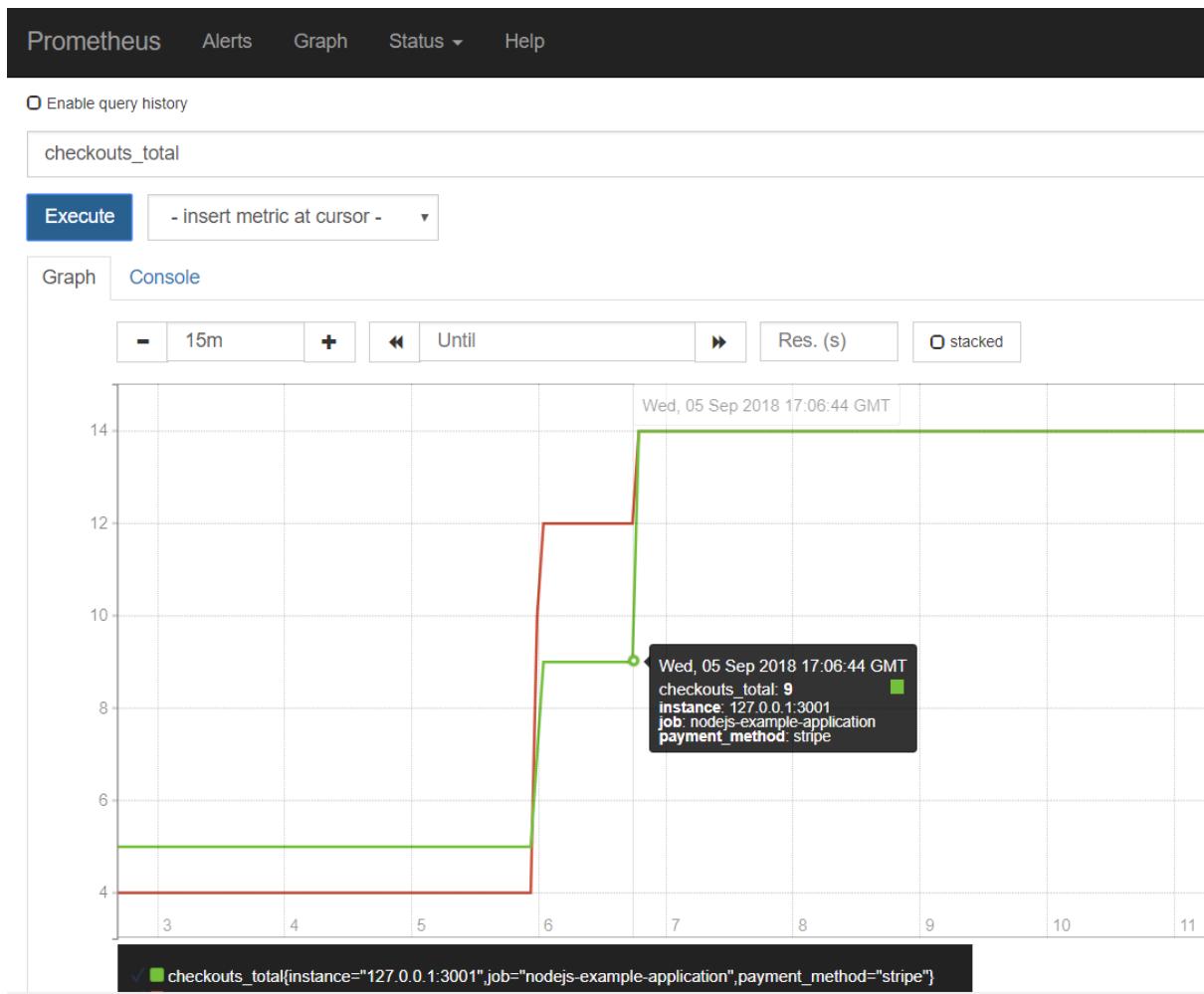
[Remove Graph](#)

[Add Graph](#)

Make a few more calls to `http://192.168.188.112:3001/checkout` .

Press Execute again in the Graph tab of the Prometheus console. The values for the `checkout_totals` metric for each of the `payment_method` dimension values are probably updated.

Switch to the Graph tab to a visual representation of the metric over time:



Another custom metric defined by the Node JS Example application is `http_request_duration_ms`. This metric is available as bucket, count and sum

The screenshot shows the Prometheus web interface. At the top, there are tabs for Prometheus, Alerts, Graph, Status, and Help. Below the tabs, there is a checkbox labeled "Enable query history". A search bar contains the text "http\_request\_duration\_ms". A dropdown menu is open, listing three items: "http\_request\_duration\_ms\_bucket", "http\_request\_duration\_ms\_count", and "http\_request\_duration\_ms\_sum".

Select the `http_request_duration_ms_bucket` entry and press Execute. On the Console tab, you will get an overview for each of the predefined buckets (each one specifying a certain duration in microseconds of handling the request) how many requests were in that bucket (or in a lower one). In the example, 16 requests were handled within 0.1 milisecond and 27 were handled within 5 ms.

The screenshot shows the Prometheus interface with the "Graph" tab selected. At the top, there are tabs for Prometheus, Alerts, Graph, Status, and Help. Below the tabs, there is a checkbox labeled "Enable query history". A search bar contains the text "http\_request\_duration\_ms\_bucket". Below the search bar, there is a button labeled "Execute" and a dropdown menu with "http\_request\_duration\_ms" selected. The main area displays a table of metrics. The table has two columns: "Element" and "Value". The "Element" column lists various histogram buckets, and the "Value" column shows the count of requests for each bucket. The table includes the following data:

Element	Value
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="+Inf",method="GET",route="/checkout"}</code>	28
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="0.1",method="GET",route="/checkout"}</code>	16
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="100",method="GET",route="/checkout"}</code>	28
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="15",method="GET",route="/checkout"}</code>	28
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="200",method="GET",route="/checkout"}</code>	28
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="300",method="GET",route="/checkout"}</code>	28
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="400",method="GET",route="/checkout"}</code>	28
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="5",method="GET",route="/checkout"}</code>	27
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="50",method="GET",route="/checkout"}</code>	28
<code>http_request_duration_ms_bucket{code="304",instance="127.0.0.1:3001",job="nodejs-example-application",le="500",method="GET",route="/checkout"}</code>	28

At the bottom of the table, there is a "Remove Graph" link. Below the table, there is a "Add Graph" button.

Note: the value for this Histogram metric is set in the server.js file in lines 63 through 71.

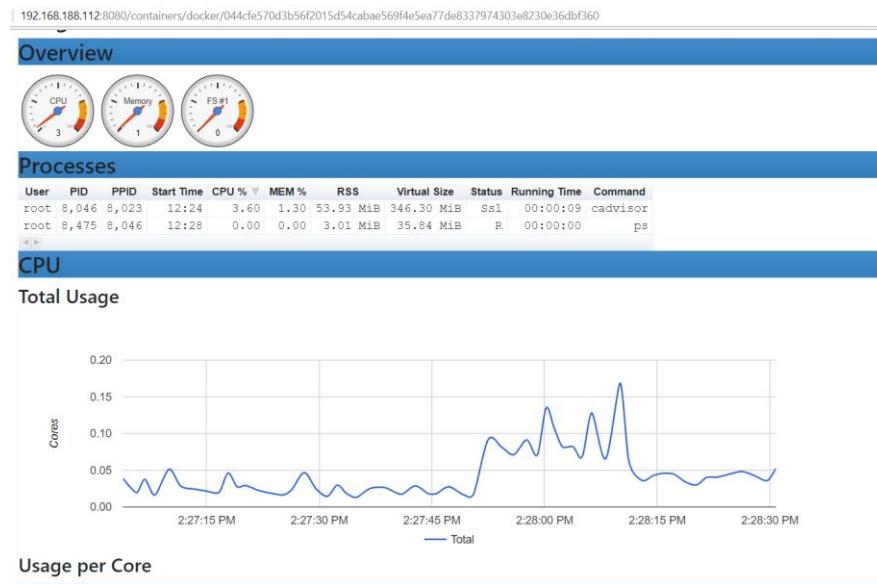
## cAdvisor – The Docker Container Exporter

In the same way the Node exporter provides metrics about the machine, cAdvisor is an exporter that provides metrics about *cgroups*. CGroups are a Linux kernel isolation feature that are usually used to implement containers on Linux. cAdvisor (short for **container Advisor**) analyzes and exposes resource usage and performance data from running containers. cAdvisor exposes Prometheus metrics out of the box.

cAdvisor itself can easily be run as a Docker container. Use the following statement to run a Docker container with cAdvisor inside it; this cAdvisor instance will start observing the Docker Engine it is running in and it will publish metrics for Prometheus to scrape:

```
docker run \
    --volume=/:/rootfs:ro \
    --volume=/var/run:/var/run:rw \
    --volume=/sys:/sys:ro \
    --volume=/var/lib/docker/:/var/lib/docker:ro \
    --volume=/dev/disk/:/dev/disk:ro \
    --publish=8080:8080 \
    --detach=true \
    --name=cadvisor \
    google/cadvisor:v0.28.3
```

Once the container is running, you can see the metrics produced by cAdvisor at <http://192.168.188.112:8080/metrics>. (check <http://192.168.188.112:8080/containers> for the normal UI for cAdvisor).



In order for Prometheus to scrape the metrics from cAdvisor, we have to add cAdvisor as target in the prometheus.yml file.

Open prometheus.yml in an editor and add this snippet:

```
- job_name: 'cadvisor_ub18_vm'  
  scrape_interval: 5s  
  static_configs:  
    - targets:  
      - 127.0.0.1:8080
```

Save the changes. Restart Prometheus.

Now check the list of targets. The cAdvisor should be added:

The screenshot shows the Prometheus web interface with the 'Targets' tab selected. At the top, there are navigation links: Prometheus, Alerts, Graph, Status, and Help. Below the tabs, there are two buttons: 'All' (selected) and 'Unhealthy'. A search bar contains the text 'cadvisor\_ub18\_vm (1/1 up)'. A 'show less' link is visible next to the search bar. The main table has columns: Endpoint, State, Labels, Last Scrape, and Error. One row is present: 'http://127.0.0.1:8080/metrics' with state 'UP', label 'instance="127.0.0.1:8080"', last scraped 2.322s ago, and no errors.

Endpoint	State	Labels	Last Scrape	Error
http://127.0.0.1:8080/metrics	UP	instance="127.0.0.1:8080"	2.322s ago	

The metrics from cAdvisor are prefixed with `container_`. All container specific metrics have labels `id` and `name` – referring to the unique identifier and name of the Docker container.

In the Graph tab of the Prometheus web ui, start by exploring the `container_start_time_seconds` metric, which records the start time of containers (in seconds).

The table below lists some other example expressions

Expression	Description
<code>rate(container_cpu_usage_seconds_total{name="grafana"}[1m])</code>	The <a href="#">cgroup</a> 's CPU usage in the last minute (split up by core)
<code>container_memory_usage_bytes{name="mysql-db"}</code>	The cgroup's total memory usage (in bytes)
<code>rate(container_network_transmit_bytes_total[1m])</code>	Bytes transmitted over the network by the container per second in the last minute

Expression	Description
rate(container_network_receive_bytes_total[1m])	Bytes received over the network by the container per second in the last minute

Resource: documentation on cAdvisor - <https://prometheus.io/docs/guides/cadvisor/> .

## Observing the Unobservable - the BlackBox Exporter

Mostly, metrics are exported from within or at least very close the system that is to be monitored. Metrics are exported by an application itself or exporters are running on the same system to tap into the observed component.

This is however not always the case. Sometimes we cannot get into the application or even close to it. Or sometimes we do not want to observe from within the system but rather from much farther away, just like a business user would.

The BlackBox Exporter can be used in general – and therefore also in these two cases – to perform ICMP, TCP, HTTP, and DNS probing. The results of this probing are exported as regular Prometheus metrics.

In order to try out the Black Box Exporter, you can run the Docker Container Image:

```
docker run -d -p 9115:9115 --name blackbox_exporter -v `pwd`:/config  
prom/blackbox-exporter
```

You can access the UI for the Black Box Exporter at : <http://192.168.188.112:9115/>.

Try out the probing mechanism of the Black Box Exporter – and the Prometheus metrics format it returns – by entering a URL like this one in your browser:

[http://192.168.188.112:9115/probe?target=github.com&module=http\\_2xx](http://192.168.188.112:9115/probe?target=github.com&module=http_2xx)

Make a deliberate mistake in the url – for example:

[http://192.168.188.112:9115/probe?target=github.comx&module=http\\_2xx](http://192.168.188.112:9115/probe?target=github.comx&module=http_2xx) – and see how the metrics change.

Black Box Exporter can be configured with all the endpoints it should watch and check the health of. This can be done from a scrape-config in the prometheus.yml file. Edit the file and add this snippet:

```
- job_name: blackbox  
  metrics_path: /probe  
  params:  
    module: [http_2xx]  
  static_configs:  
    - targets:  
        - http://www.prometheus.io  
        - http://github.com  
        - https://hub.docker.com  
        - http://my.own.domain  
  relabel_configs:  
    - source_labels: [__address__]  
      target_label: __param_target  
    - source_labels: [__param_target]
```

```

target_label: instance
- target_label: __address__
  replacement: 127.0.0.1:9115

```

Save changes. Then restart Prometheus.

Check the Prometheus targets:

The screenshot shows the Prometheus UI with the 'Targets' tab selected. There are two buttons at the top: 'All' (selected) and 'Unhealthy'. Below them is a section titled 'blackbox (3/4 up)' with a 'show less' link. A table lists four endpoints:

Endpoint	State	Labels	Last Scrape	Error
http://127.0.0.1:9115/probe module="http_2xx" target="http://github.com"	UP	instance="http://github.com"	6.615s ago	
http://127.0.0.1:9115/probe module="http_2xx" target="http://my.own.domain"	UNKNOWN	instance="http://my.own.domain"	Never	
http://127.0.0.1:9115/probe module="http_2xx" target="http://www.prometheus.io"	UP	instance="http://www.prometheus.io"	4.726s ago	
http://127.0.0.1:9115/probe module="http_2xx" target="https://hub.docker.com"	UP	instance="https://hub.docker.com"	3.436s ago	

## Targets

All Unhealthy

**blackbox (3/4 up)** [show less](#)

Endpoint	State	Labels	Last Scrape	Error
http://127.0.0.1:9115/probe module="http_2xx" target="http://github.com"	UP	instance="http://github.com"	6.615s ago	
http://127.0.0.1:9115/probe module="http_2xx" target="http://my.own.domain"	UNKNOWN	instance="http://my.own.domain"	Never	
http://127.0.0.1:9115/probe module="http_2xx" target="http://www.prometheus.io"	UP	instance="http://www.prometheus.io"	4.726s ago	
http://127.0.0.1:9115/probe module="http_2xx" target="https://hub.docker.com"	UP	instance="https://hub.docker.com"	3.436s ago	

One target is added – blackbox – with four endpoints. After a little while, three are probably, hopefully up. The last one will probably be up eventually – although the UP-ness of the my.own.domain probe only indicates that the probe is up (the Black Box Exporter) – but not that the endpoint my.own.domain could be reached.

The blackbox exporter produced metrics with the prefix `probe_`. Check in the Graph tab for these metrics:

The screenshot shows the Prometheus UI with the 'Graph' tab selected. At the top, there is a search bar containing 'probe\_'. Below it, a list of metric names is displayed:

- probe\_dns\_lookup\_time\_seconds
- probe\_duration\_seconds
- probe\_failed\_due\_to\_regex
- probe\_http\_content\_length
- probe\_http\_duration\_seconds
- probe\_http\_redirects
- probe\_http\_ssl
- probe\_http\_status\_code
- probe\_http\_version
- probe\_ip\_protocol
- probe\_ssl\_earliest\_cert\_expiry
- probe\_success

And inspect for example the metric `probe_http_duration_seconds`.

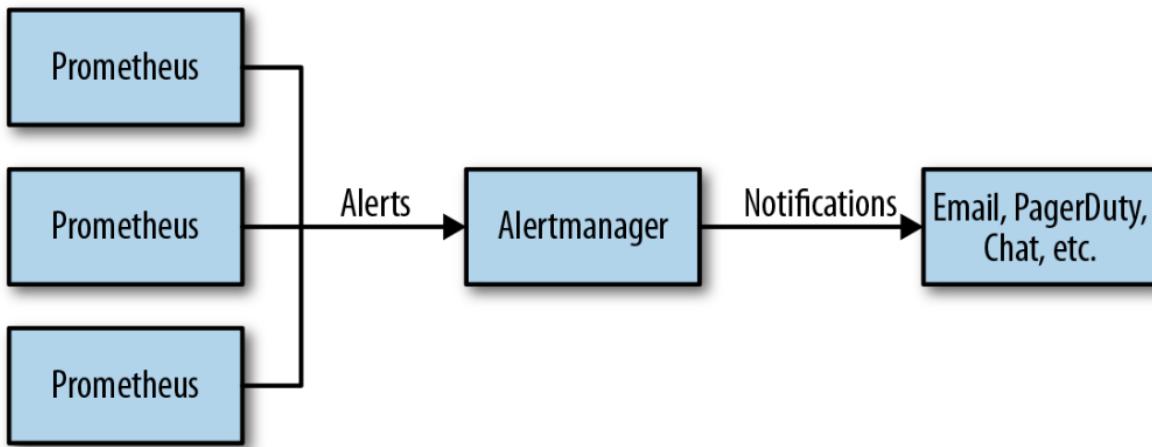


Resource: details on the Black Box exporter:

[https://github.com/prometheus/blackbox\\_exporter/blob/master/README.md](https://github.com/prometheus/blackbox_exporter/blob/master/README.md).

## Alerts

There are two parts to alerting. First, adding alerting rules to Prometheus, defining the logic of what constitutes an alert. Secondly, configuring the Alertmanager to convert firing alerts into notifications, such as emails, pages, and chat messages.



### Configure Alert Rules on Prometheus

Alert Rules can be configured in yml files that are referenced from `prometheus.yml`. In the home directory for Prometheus, create a new file called `rules.yml`:

```
cd ~ /prometheus-2.3.2.linux-amd64
```

```
vi rules.yml
```

and enter the following content into this new file:

```
groups:
  - name: target_rules
    rules:
      - alert: InstanceDown
        expr: up == 0
        for: 1m
```

Save the change.

This configures an alert called `InstanceDown` that should fire if the metric `up` – which for each scrape job indicates of the corresponding target is available – equals 0 and does so for at least 1 minute. This condition is true if the target is not available.

Stop Prometheus if it is running.

Edit `prometheus.yml`:

```
vi prometheus.yml
```

and type

```
- "rules.yml"
```

under “rule\_files:” . Save the change.

Start Prometheus again.

If you now check under Alerts in the Prometheus console, you should find one alert active – because the MySQL target can still not be scraped:

The screenshot shows the Prometheus interface with the 'Alerts' tab selected. A single alert is listed under the heading 'InstanceDown (1 active)'. The alert configuration is shown in a code block:

```
alert: InstanceDown
expr: up == 0
for: 1m
```

A table below lists the alert details:

Labels	State	Active Since	Value
alername="InstanceDown" instance="localhost:9104" job="mysqld"	FIRING	2018-09-05 18:05:39.456891295 +0000 UTC	0

The InstanceDown alert – which is automatically configured – is firing because one of the target instances has been down for at least one minute.

No notification is sent and no automatic remediation is performed. This alert will continue to fire until the MySQL Exporter is back on line – or the Prometheus configuration has been changed.

## Define a Business Alert Rule

Alerts can be defined on any metric – to watch out for technical conditions, related to infrastructure and platform errors, or to guard business conditions. We will look at a more functional, business oriented alert now – although the example is somewhat farfetched.

Define the following entry in the rules.yml file under the groups entry:

```
- name: my_custom_rules
  rules:
    - alert: CheckOutsOdd
      expr: checkouts_total{job="nodejs-example-application"} % 2 == 1
```

Here we specify that an alert should be fired if the *checkouts\_total* metric – exposed by the example Node JS application - has an odd (not even) value.

After saving this change to rule.yml, restart the Prometheus server. Check in the Status | Rules page if the new custom rule is loaded correctly.

Prometheus    Alerts    Graph    Status ▾    Help

## Rules

**example**

**Rule**

```
alert: InstanceDown
expr: up == 0
for: 1m
```

**my\_custom\_rules**

**Rule**

```
alert: CheckoutsOdd
expr: checkouts_total{job="nodejs-example-application"} % 2 == 1
```

Now you can check the current values for the `checkouts_total` metric (note: there is one value for each payment type) in the Prometheus UI:

Prometheus    Alerts    Graph    Status ▾    Help

Enable query history

checkouts\_total

Load time: 23ms  
Resolution: 14s  
Total time series: 2

**Execute**    - insert metric at cursor - ▾

**Graph**    Console

Element	Value
<code>checkouts_total{instance="127.0.0.1:3001",job="nodejs-example-application",payment_method="paypal"}</code>	32
<code>checkouts_total{instance="127.0.0.1:3001",job="nodejs-example-application",payment_method="stripe"}</code>	34

Remove Graph

Add Graph

In the Alerts tab, you can check if the `CheckOutsOdd` alert is firing:

# Alerts

Show annotations

## InstanceDown (1 active)

## CheckOutsOdd (0 active)

```
alert: CheckOutsOdd
expr: checkouts_total{job="nodejs-example-application"}
% 2 == 1
```

If it is not firing, make one or two requests to <http://192.168.188.112:3001/checkout>. Before too long, the alert will fire – or will stop firing.

# Alerts

Show annotations

## InstanceDown (1 active)

## CheckOutsOdd (0 active)

```
alert: CheckOutsOdd
expr: checkouts_total{job="nodejs-example-application"}
% 2 == 1
```

Note: The expression used in the rules.yml entry can also be tested in PromQL field in the web ui, , simply by clicking on the expression in the alert rule:

The screenshot shows the Prometheus web interface with the following details:

- Top Navigation:** Prometheus, Alerts, Graph, Status ▾, Help.
- Query Bar:** A text input field contains the query `checkouts_total{job="nodejs-example-application"} % 2 == 1 |`. To the right, performance metrics are displayed: Load time: 6ms, Resolution: 14s, Total time series: 1.
- Buttons:** Execute (highlighted in blue), - insert metric at cursor - ▾.
- Graph/Console Selection:** Graph (selected) and Console.
- Table Results:** A table shows the results of the query. It has two columns: Element and Value. One row is present: `{instance="127.0.0.1:3001",job="nodejs-example-application",payment_method="stripe"}` with a value of 1.
- Buttons:** Remove Graph.

### Optional: Add Annotations to Alerts

The Alert definition in the rules file can be further enhanced with labels and annotations. Labels can be used later on for routing alerts and annotations provided human-oriented context for an alert. Labels are for example used to indicate the severity of an alert, its business domain or to suggest the team or specialism required to investigate.

Edit the rules.yml file and extend the alert node with:

```
labels:
  severity: purple
  service: finance
```

Annotations provide context that are available to human staff. They consist of a combination of static text and dynamically evaluated expressions. The expression `$value` can be used to include the value of the alert expression in an annotation and the expression `$.labels` returns a map with the labels from which an individual label can be retrieved like this: `{$labels.job}`.

Specify annotations for the CheckOutsOdd alert like this:

```
annotations:
  descriptions: 'The number of checkouts is odd for payment method
  {$labels.payment_method}} . This has been recognized as a business oddity
  that deserves notification'
  summary: 'Odd number of Checkouts for payment method
  {$labels.payment_method}}'
```

Restart Prometheus.

When the alert conditions are satisfied, you will find the values for the newly defined labels as well as the annotation in the Alert page of the Prometheus console:

Prometheus   Alerts   Graph   Status ▾   Help

# Alerts

Show annotations

## CheckOutsOdd (2 active)

```
alert: CheckOutsOdd
expr: checkouts_total{job="nodejs-example-application"} % 2 == 1
labels:
  service: finance
  severity: purple
annotations:
  descriptions: The number of checkouts is odd for payment method {{$labels.payment_method}}
    . This has been recognized as a business oddity that deserves notification
  summary: Odd number of Checkouts for payment method {{$labels.payment_method}}
```

## Labels

	State
alername="CheckOutsOdd" instance="127.0.0.1:3001" job="nodejs-example-application" payment_method="paypal" service="finance" severity="purple"	FIRING
alername="CheckOutsOdd" instance="127.0.0.1:3001" job="nodejs-example-application" payment_method="stripe" service="finance" severity="purple"	FIRING

## InstanceDown (1 active)

In a little while, you will see the actual values of the annotations in the Alertmanager – with the expressions resolved.

Documentation: see [https://prometheus.io/docs/prometheus/latest/configuration/alerting\\_rules/](https://prometheus.io/docs/prometheus/latest/configuration/alerting_rules/) and <https://petargitnik.github.io/blog/2018/01/04/how-to-write-rules-for-prometheus>

## Turning Alerts into Notifications

The alert manager keeps track of all firing alerts from one or even multiple Prometheus instances. Based on rules setup in the file `alertmanager.yml` in directory `~/alertmanager-0.15.2.linux-amd64`, it decides if notifications should be sent and if so where to. Channels for sending notifications include email, PagerDuty, HipChat, Slack, WeChat and Web Hook.

Note: The alert manager should already be installed in your environment. Either it was set up in the prepared VM – or you installed it yourself just after starting up the VM through downloading and unpacking the tar-file.

In this section, we will use a Slack channel as our notification target. We will configure the alertmanager to send notifications to a selected channel in a Slack Workspace. We will leverage the ‘Incoming WebHooks’ app in Slack – that takes the HTTP request from the Alert Manager and interprets it as a Slack message.

## Prepare Slack Workspace

You can either create and/or configure your own Slack Worksapce or make use of a predefined one.

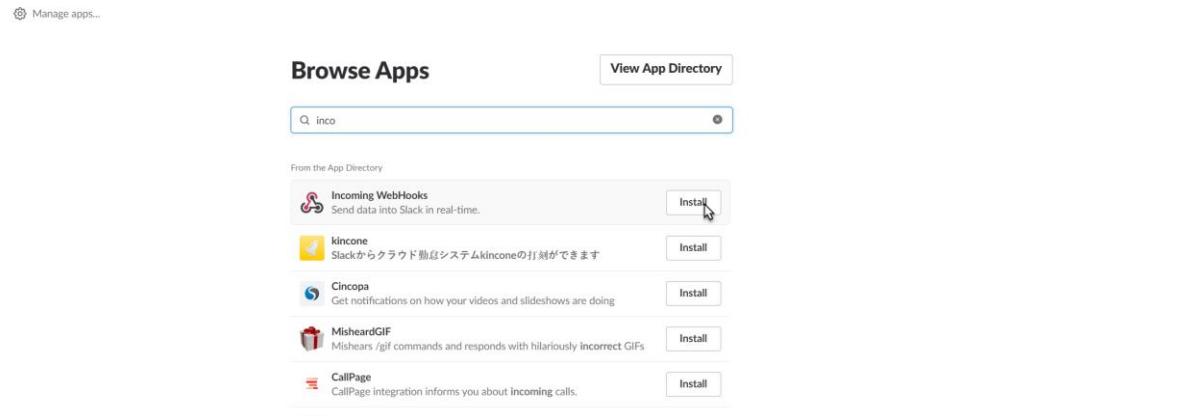
## Your own Slack Workspace

Create your own new Slack Workspace – through <https://slack.com/create> .

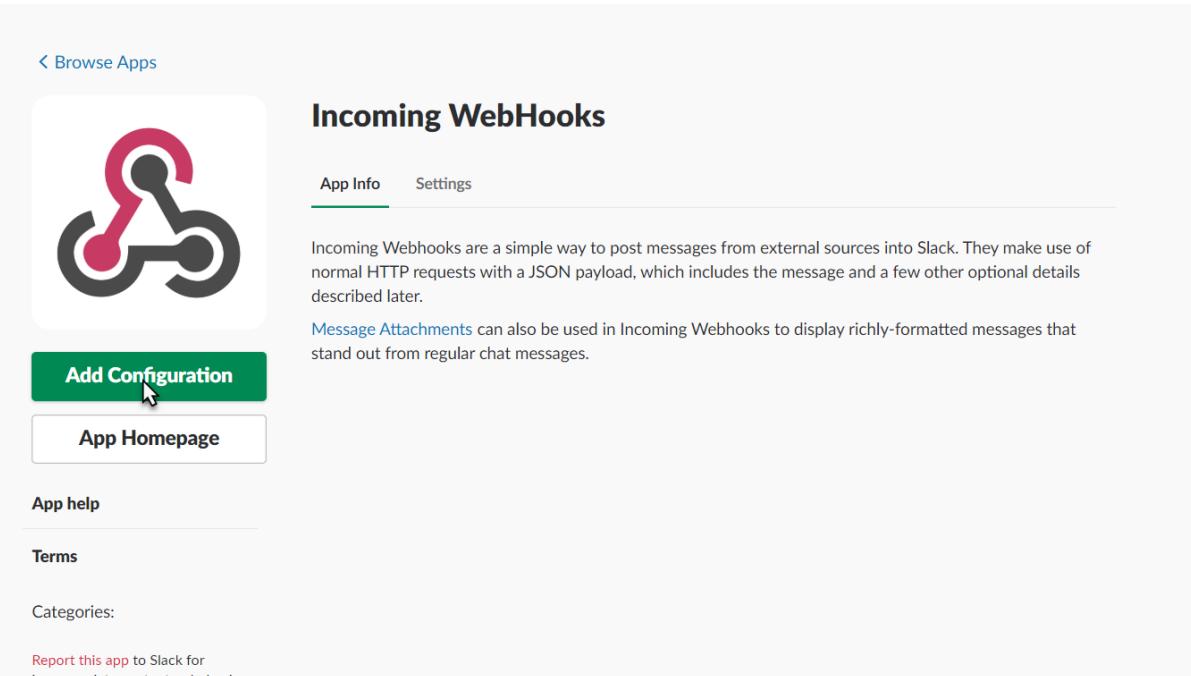
Follow the instructions to create and log in to your own new workspace.

Create the channel into which Alert notifications should be sent – this can also be the general channel.

When done, add the “Incoming WebHooks App” from App Directory to your workspace.



The screenshot shows the Slack App Directory interface. At the top, there's a search bar with the query "inco". Below it, a list of apps from the App Directory is displayed, with "Incoming WebHooks" being the first result. The "Install" button for this app is highlighted with a cursor. Other visible apps include kincone, Cinco, MishardGIF, and CallPage, each with its own "Install" button.

The screenshot shows the configuration page for the Incoming WebHooks app. It features a sidebar with links like "Add Configuration" (which is highlighted with a cursor), "App Homepage", "App help", and "Terms". The main content area is titled "Incoming WebHooks" and contains sections for "App Info" and "Settings". A descriptive text explains that Incoming Webhooks allow posting messages from external sources into Slack via HTTP requests with JSON payloads. It also mentions "Message Attachments" for richly-formatted messages. At the bottom, there are "Categories:" and a link to report inappropriate content.

Configure the Incoming WebHooks app for the specific channel:

The screenshot shows the Slack App Directory interface. At the top, there's a search bar labeled 'Search App Directory'. Below it, a message states: 'Message Attachments can also be used in Incoming Webhooks to display richly-formatted messages that stand out from regular chat messages.' A callout box titled 'New to Slack integrations?' provides a link to the 'Getting Started' guide and information about registering as a developer. The main section is titled 'Post to Channel' and shows a dropdown menu set to '#prom-notifications' with an option to 'or create a new channel'. A prominent green button at the bottom says 'Add Incoming WebHooks integration'. Below the button, a note states: 'By creating an incoming webhook, you agree to the [Slack API Terms of Service](#)'.

And click on 'Add Incoming WebHooks integration'.

## Get the WebHook URL

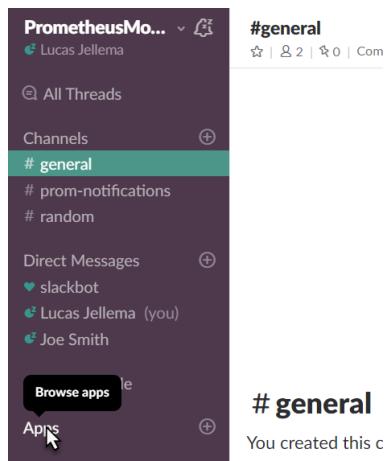
The screenshot shows the 'Incoming WebHooks' configuration page. At the top, there's a search bar labeled 'Search App Directory'. The page title is 'Incoming WebHooks' by Lucas Jellema, added on September 5th, 2018. It includes 'Disable' and 'Remove' buttons. A note about Incoming Webhooks is present, along with a 'New to Slack integrations?' callout. The 'Setup Instructions' section contains a 'close' button and a 'Webhook URL' field which is highlighted with a red border. The URL value is: `https://hooks.slack.com/services/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`.

We will configure this URL in the alert manager's configuration.

*Leverage a Predefined Workspace*

Open this URL in your browser: <https://amis-prometheus.slack.com>. Sign in with credentials [luscasjellema@gmail.com](mailto:luscasjellema@gmail.com) and password 123321.

Click on Apps in the lower left hand corner.



Click on View for the incoming-webhook app:

A screenshot of the Slack 'Browse Apps' interface. At the top, there's a search bar with placeholder text 'Search by name or category (e.g. productivity, sales)'. Below it is a section titled 'Add apps to get things done' with a sub-instruction 'Schedule meetings, share docs, and more — straight from Slack.' followed by a link 'See app suggestions'. A horizontal scroll bar is visible on the right. Below this, a single app card is listed: 'incoming-webhook' with a small flame icon. To the right of the card is a 'View' button, which has a cursor arrow pointing directly at it.

Click on Settings for the app to inspect the details:

A screenshot of the 'About this Incoming Webhook' details page. The title is 'About this Incoming Webhook' with a close button 'X'. Below it is a dark card featuring a flame icon and the text 'incoming-webhook APP'. A 'Settings' button is located in the bottom-right corner of the card. A cursor arrow points to this 'Settings' button.

About this Incoming Webhook  
Created by @Lucas Jellema on September 5, 2018.

And when the app details are shown:

The screenshot shows the Slack App Directory interface. At the top, there's a search bar labeled "Search App Directory". Below it, a navigation bar includes "Browse", "Manage", and "Build" buttons, along with a dropdown menu for "Prometheus". The main content area displays the "Incoming WebHooks" integration, which was added by Lucas Jellema on September 5th, 2018. A description explains that Incoming Webhooks allow posting messages from external sources into Slack via normal HTTP requests with a JSON payload. It also mentions that message attachments can be used. There are "Disable" and "Remove" buttons at the top right.

Scroll down to locate the webhook url:

This screenshot shows the "Incoming WebHooks" configuration page. Under the heading "Webhook URL", it says "Send your JSON payloads to this URL." followed by a text input field containing the URL: <https://hooks.slack.com/services/TCN213DQV/BCMPEER2P/gJiJQLhLLNdbxwe1>. Below the URL is a "Show setup instructions" link. At the bottom right of the URL field, there are "Copy URL" and "Regenerate" buttons, with a cursor hovering over the "Copy URL" button.

And copy this URL. You need it to configure the (Prometheus) Alert Manager.

Configure Alert Manager to Send Notifications to Slack

Navigate to directory `~/alertmanager-0.15.2.linux-amd64/`:

```
cd ~/alertmanager-0.15.2.linux-amd64/
```

Configure `alertmanager.yml`

Add this entry under the `receivers` node, just after `web.hook`:

```
- name: slack_alerts
  slack_configs:
    - api_url: <the WebHook URL for Slack>
      channel: '#prom-notifications'
```

Change the value of the `receiver` property under the `route` root node from '`web.hook`' to '`slack_alerts`':

```
route:
  group_by: ['alertname']
  group_wait: 10s
  group_interval: 10s
  repeat_interval: 1h
  receiver: 'slack_alerts'
```

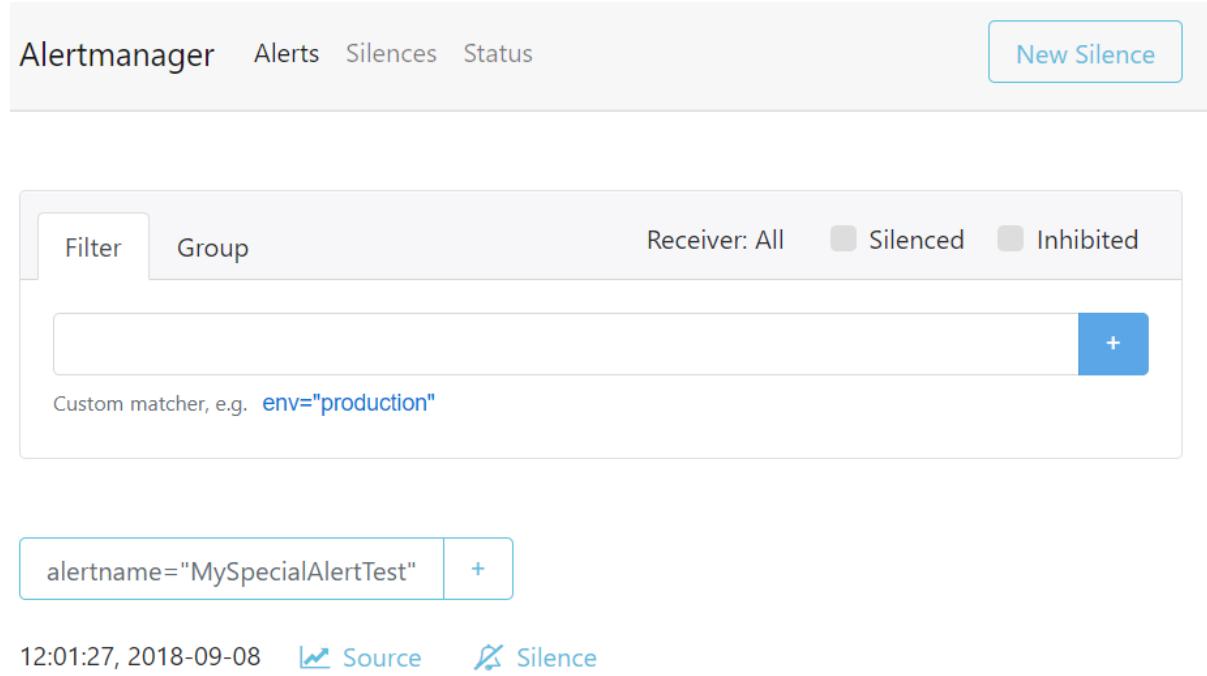
Start Alertmanager

```
nohup ./alertmanager &
```

The Alert Manager also has a Web UI, which is available at: <http://192.168.188.112:9093>.

Test – have an alert raised directly, not from Prometheus:

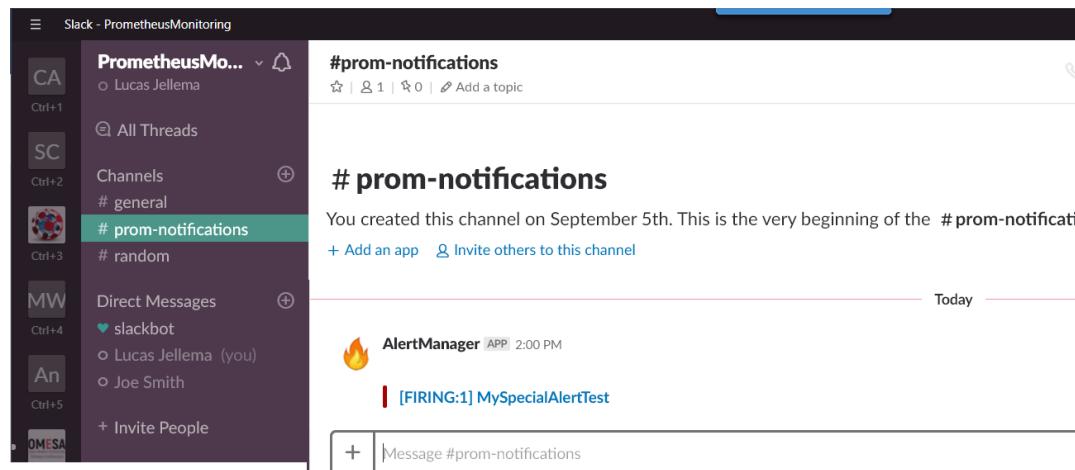
```
curl -d '[{"labels": {"alertname": "MySpecialAlertTest"}}]'  
http://localhost:9093/api/v1/alerts
```



The screenshot shows the Alertmanager web interface. At the top, there are tabs for 'Alertmanager', 'Alerts', 'Silences', and 'Status', with 'Alerts' selected. A 'New Silence' button is in the top right. Below the tabs, there are filters: 'Filter' (selected), 'Group', 'Receiver: All' (with 'Silenced' and 'Inhibited' checkboxes), and a search bar containing 'Custom matcher, e.g. env="production"'. A '+' button is next to the search bar. The main area displays a table with one row:

alertname="MySpecialAlertTest"	+
12:01:27, 2018-09-08	<a href="#">Source</a>

And in Slack:



The screenshot shows a Slack channel named '#prom-notifications'. The sidebar shows various workspace members and channels. A message from 'AlertManager' (APP) at 2:00 PM is shown, indicating an alert has fired: '[FIRING:1] MySpecialAlertTest'. The message includes a small fire emoji.

#### [Configure Prometheus to Forward Alerts to Alert Manager](#)

Now let's try to get the alerts identified by Prometheus into the Alert Manager.

Edit `prometheus.yml`. Configure the locally active Alert Manager in the `alerting` node by specifying the end point `127.0.0.1:9093` as target;

**alerting:**

**alertmanagers:**

- **static\_configs:**

- **targets:**

- **127.0.0.1:9093**

Save the changes and restart Prometheus.

The Alerts that are visible on the Alerts tab in the Prometheus Console

The screenshot shows the Prometheus Alerts tab with two active alerts listed:

- CheckOutsOdd** (1 active)  
alert: CheckOutsOdd  
expr: checkouts\_total{job="nodejs-example-application"} % 2 == 1  
Labels:  
alertname="CheckOutsOdd" instance="127.0.0.1:3001" job="nodejs-example-application" payment\_method="stripe"  
State: FIRING Active Since: 2018-09-08 12:38:42.177622548 +0000 UTC Value: 1
- InstanceDown** (1 active)  
alert: InstanceDown  
expr: up == 0  
for: 1m  
Labels:  
alertname="InstanceDown" instance="localhost:9104" job="mysql"  
State: FIRING Active Since: 2018-09-08 12:38:50.782333327 +0000 UTC Value: 0

are now also visible in the Web UI of the Alert Manager:

The screenshot shows the Alertmanager Web UI with the following interface elements:

- Header: Alertmanager Alerts Silences Status New Silence
- Filter: Filter Group
- Receiver: slack\_alerts
- Silenced and Inhibited status indicators
- Custom matcher input field: Custom matcher, e.g. env="production"
- Alert list:
  - CheckOutsOdd** (highlighted with a red box)  
12:32:42, 2018-09-08 Source Silence  
payment\_method="stripe" + job="nodejs-example-application" + instance="127.0.0.1:3001" +
  - InstanceDown** (highlighted with a red box)  
12:31:50, 2018-09-08 Source Silence  
job="mysql" + instance="localhost:9104" +

These alerts are sent as notification to the Slack channel, as per the configuration you have just created in the alertmanager.yml file:

#prom-notifications

☆ | 1 | 0 | Add a topic

You created this channel on September 2nd. This is the very beginning of the #prom-notifications channel.

+ Add an app | Invite others to this channel

Today

**AlertManager APP 2:00 PM**

[FIRING:1] MySpecialAlertTest

**AlertManager APP 2:31 PM**

[FIRING:1] InstanceDown (localhost:9104 mysqld)

[FIRING:1] CheckOutsOdd (127.0.0.1:3001 nodejs-example-application stripe)

### Optional: Create Pretty Notification Messages using Templates

The notifications in Slack are a little unrefined. Our core technical staff may be fine with this, but some engineers may prefer a little more refined message. That can be done – using notification templates configured for the Alert Manager in `alertmanager.yml`.

First create a special route for the `CheckOutsOdd` alert in a `routes` node under the `route` root.

`routes:`

```
- receiver: businessticket
  group_by: [service]
  match:
    alertname: CheckOutsOdd
```

In this route, we can also add instructions for [more complex] grouping, throttling and repeating notifications.

Then, create a new receiver entry in this same file, called `businessticket` and defined like this:

```
- name: businessticket
  slack_configs:
    - api_url: <Incoming WebHook URL Slack Workspace>
      channel: '#prom-notifications'
      title: 'Alerts in Service {{ .GroupLabels.service }}'
      text: >
        {{ .Alerts | len }} alerts:
        {{ range .Alerts }}
          {{ .Labels.SortedPairs }}{{ .Name }}={{ .Value }} {{ end }}
```

Context:

```
  {{ range .Annotations.SortedPairs }}{{ .Name }}:{{ .Value }} {{ end }}  
}}
```

Wiki: <http://wiki.mycompany/{{ .Labels.alertname }}>

```
  {{ end }}
```

Note: the blank lines are intentional. Simply using \n did not create the new line characters I was hoping for.

Save the file alertmanager.yml with these changes and restart the alertmanager. This configuration file is reloaded. When next you trigger alerts, the notification shown in Slack will be extended with the information configured in the template:

### Alerts in Service finance

2 alerts:

```
alertname=CheckOutsOdd instance=127.0.0.1:3001 job=nodejs-example-application payment_method=paypal service=finance severity=purple
```

Context:

descriptions:The number of checkouts is odd for payment method paypal . This has been recognized as a business oddity that deserves notification summary:Odd number of Checkouts for payment method paypal Wiki:

<http://wiki.mycompany/CheckOutsOdd>

```
alertname=CheckOutsOdd instance=127.0.0.1:3001 job=nodejs-example-application payment_method=stripe service=finance severity=purple
```

Context:

descriptions:The number of checkouts is odd for payment method stripe . This has been recognized as a business oddity that deserves notification summary:Odd number... [Show more](#)

### Resources

Using the Slack notification channel with the Alert Manager <https://www.robustperception.io/using-slack-with-the-alertmanager>

Documentation on Notification Templates:

[https://prometheus.io/docs/alerting/notification\\_examples/](https://prometheus.io/docs/alerting/notification_examples/)

## Dashboards with Grafana

A lot of information about the metrics gathered by Prometheus can already be learned from the Prometheus Web UI. The alert rules in combination with the Alert Manager's capability of translating firing alerts into notifications into virtually any channel allow us to take action when undesirable conditions occur. What then do we need a dashboard for?

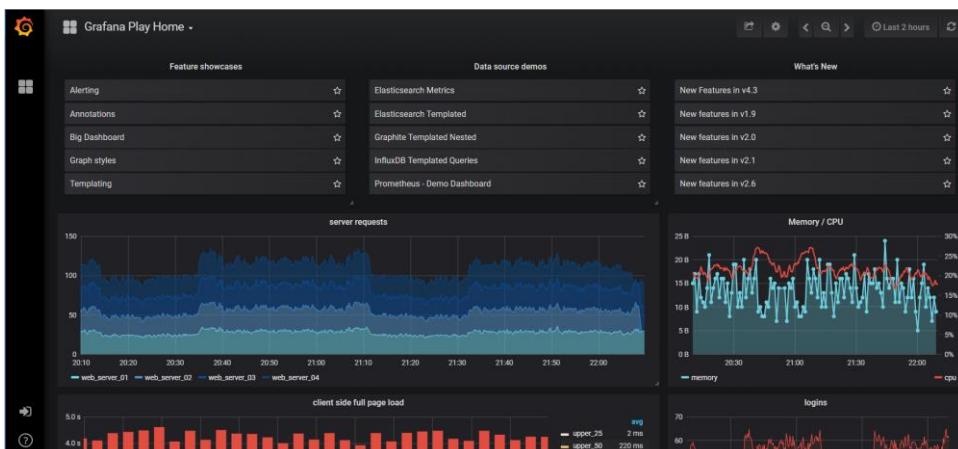
A well-designed dashboard – and that is a stiff challenge right there – can support engineers acting on alerts by providing contextual information about the alert itself and the components from which the alert originated and their recent history. The dashboard also provides insight – both for incident analysis as well as for more tactical insight – in trends over time, such as slowly increasing load or decreasing remaining capacity.

A common companion to Prometheus for Dashboarding – although both play with others too – is Grafana. We will now take a quick look on how we can use Grafana to visualize the metrics gathered and preprocessed by Prometheus.

### Try out Grafana On Line

Navigate in your browser to: <https://grafana.com/grafana#visualize>. You can scroll to get a quick introduction to all main features of Grafana.

To play with a number of fancy live dashboards and have real interaction, navigate to <https://play.grafana.org>:



### Get Going with Grafana on your laptop

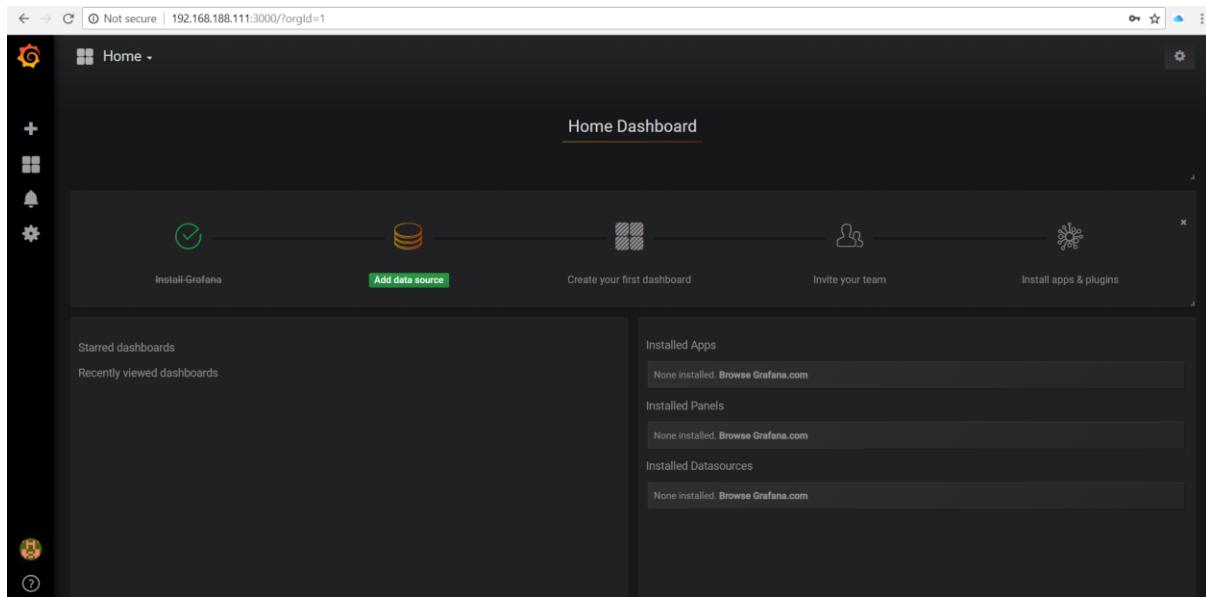
Run Grafana in a Docker container using the following command:

```
docker run -d --name=grafana -p 3000:3000 grafana/grafana:5.2.3
```

When the container is running – this will take a few minutes because the Grafana Docker Container Images needs to be downloaded –, the Grafana UI can be accessed on your laptop at <http://192.168.188.112:3000>.

Default credentials are: admin/admin.

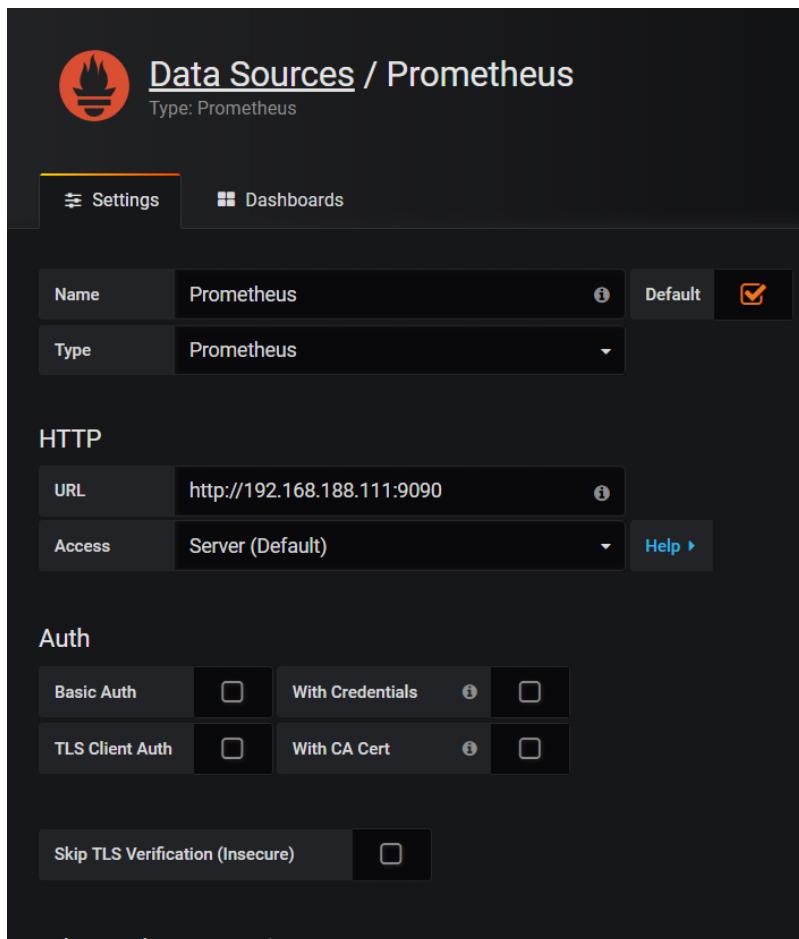
Note: when logging in for the first time, you are prompted to change the password. In this workshop environment you can safely change to *admin* (so not really change at all).



Grafana uses data sources to fetch information used for graphs. There are a variety of types of data sources supported out of the box, including MySQL, CloudWatch, Elastic Search, OpenTSDB, PostgreSQL, and of course, Prometheus. A Grafana dashboard can have graphs from variety of sources, and you can even mix sources in a graph panel.

Let's now add a Data Source for your Prometheus instance.

Click on Add data source and add a data source with a Name of **Prometheus**, a Type of **Prometheus**, and a URL of <http://192.168.188.112:9090>



The screenshot shows the 'Data Sources / Prometheus' configuration page in Grafana. At the top, there is a logo of a torch and the text 'Data Sources / Prometheus'. Below it, it says 'Type: Prometheus'. There are two tabs: 'Settings' (selected) and 'Dashboards'. Under 'Settings', there are two tables:

Name	Prometheus	Default	<input checked="" type="checkbox"/>
Type	Prometheus		

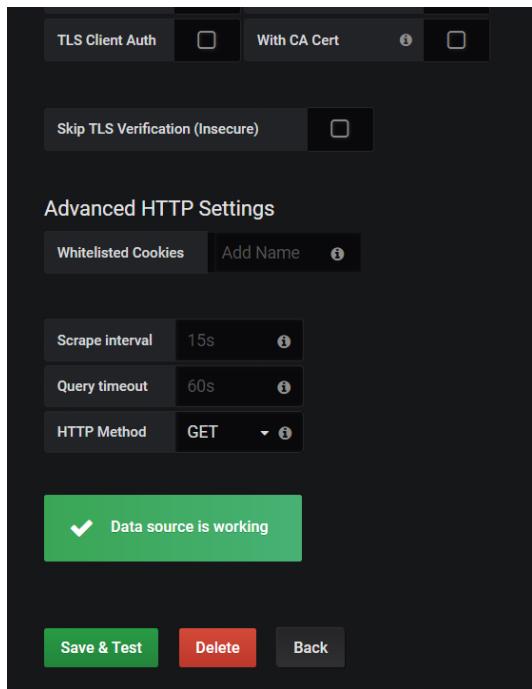
URL	http://192.168.188.111:9090	<input type="button" value="i"/>
Access	Server (Default)	<input type="button" value="Help &gt;"/>

Below these tables is a section titled 'Auth' with two rows of checkboxes:

Basic Auth	<input type="checkbox"/>	With Credentials	<input type="checkbox"/>
TLS Client Auth	<input type="checkbox"/>	With CA Cert	<input type="checkbox"/>

At the bottom, there is a checkbox for 'Skip TLS Verification (Insecure)'.

Press Save & Test.

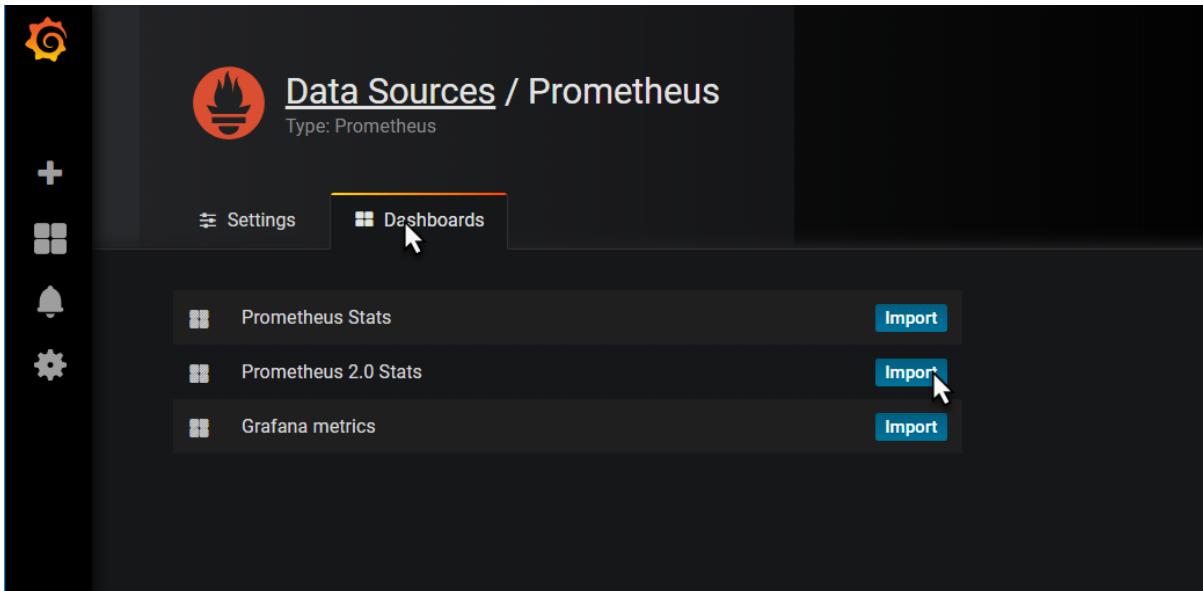


This screenshot shows the 'Save & Test' confirmation dialog. It contains the same 'Auth' settings as the previous screen. Below them is a section titled 'Advanced HTTP Settings' with three input fields:

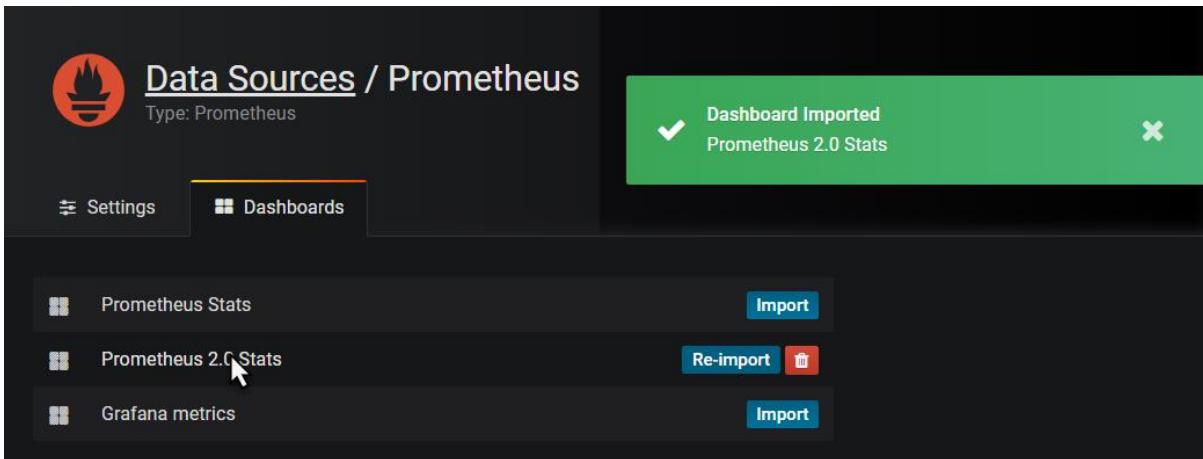
Whitelisted Cookies	<input type="button" value="Add Name"/>
Scrape interval	15s <input type="button" value="i"/>
Query timeout	60s <input type="button" value="i"/>
HTTP Method	GET <input type="button" value="i"/>

A green button at the bottom left says 'Data source is working' with a checkmark icon. At the very bottom are three buttons: 'Save & Test' (green), 'Delete' (red), and 'Back'.

Toggle to the tab *Dashboards* and click to import the *Prometheus 2.0 Stats* dashboard.

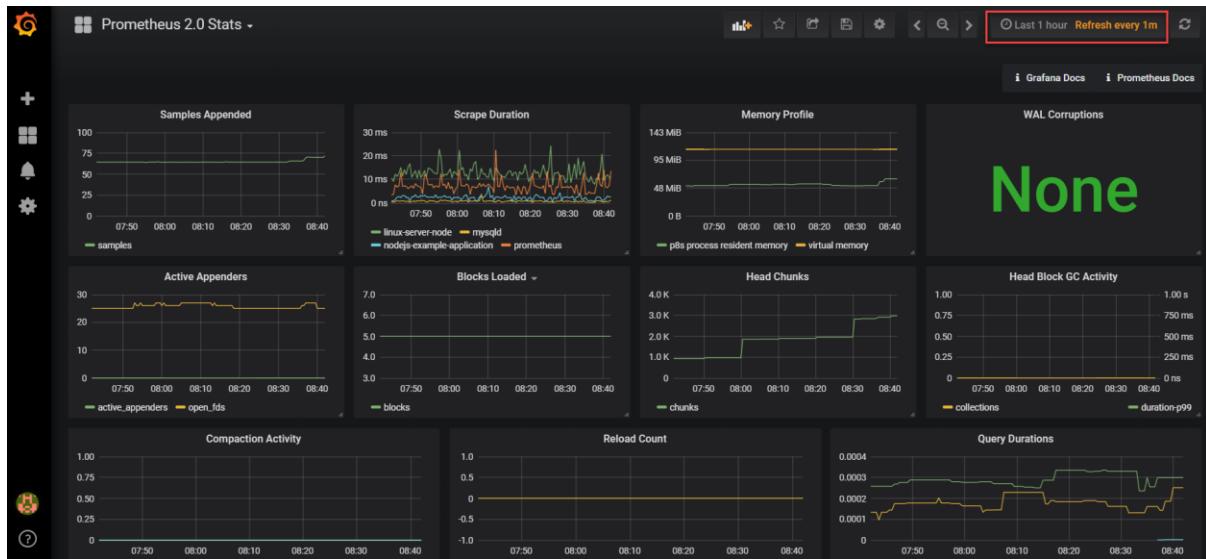


This will import the definition of this dashboard to quickly get us going with a dashboard that displays various metrics on the operational condition of our Prometheus instance, supporting those engineers that have a responsibility for keeping Prometheus in good working order.



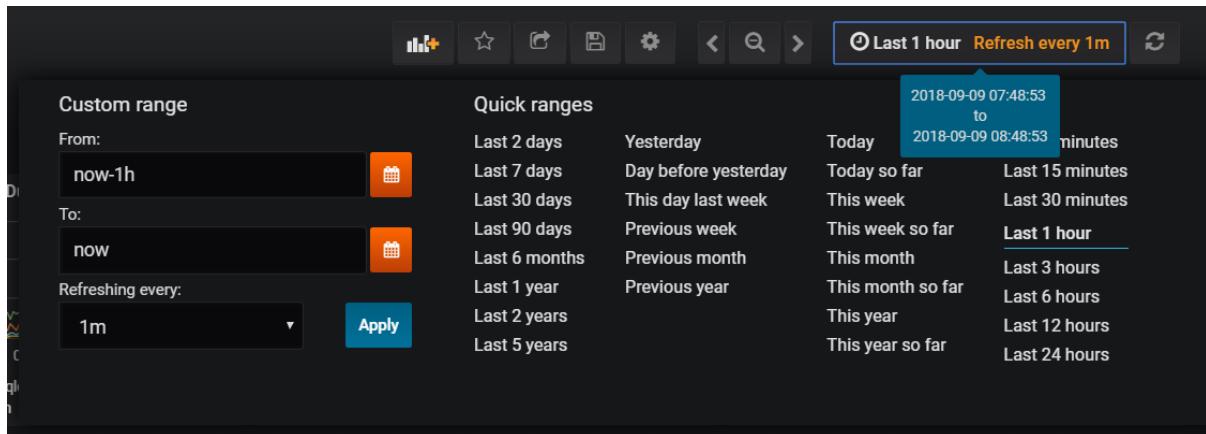
When the dashboard is imported, click on the name of the dashboard – which is a hyperlink to now open the dashboard.

The dashboard appears:



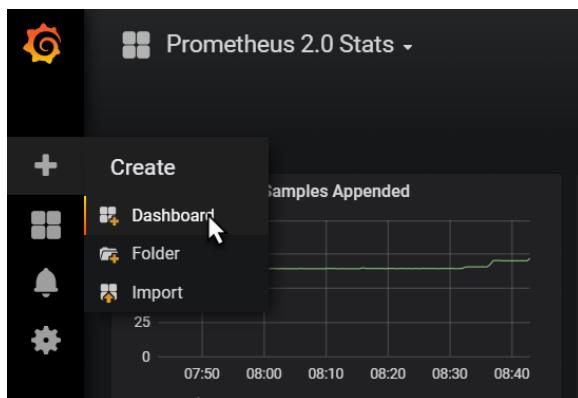
It shows a little of what Grafana is capable of, in terms of visualizing and organizing data. Hover over the graphs with your mouse for example.

Click on the time window widget in the upper right hand corner, to zoom in and out over a time range:

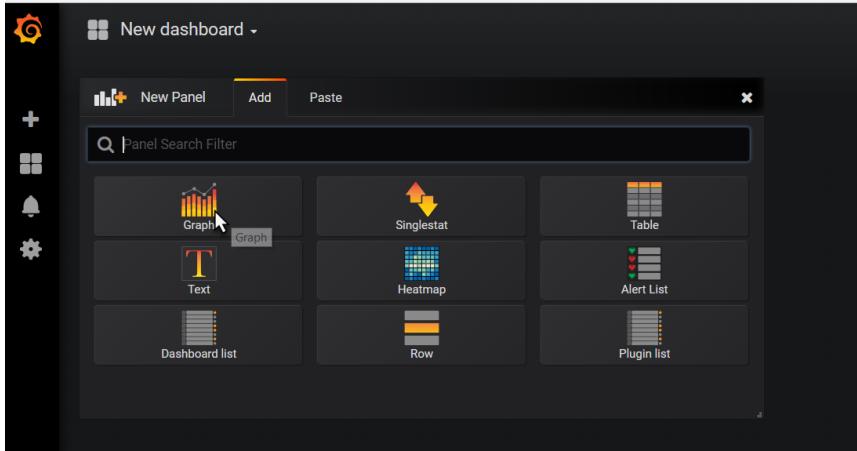


## Creating a New Dashboard

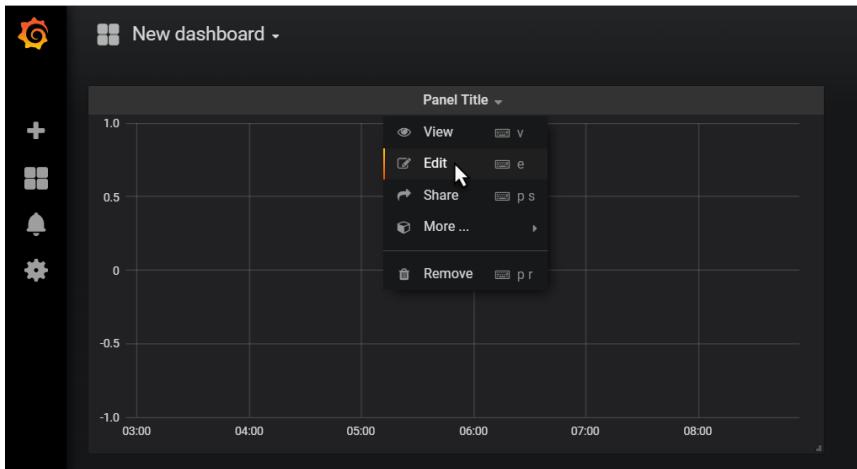
To create your own new dashboard, click on the plus icon in the upper left hand area of the page and select the create a new Dashboard:



Click on Graph:

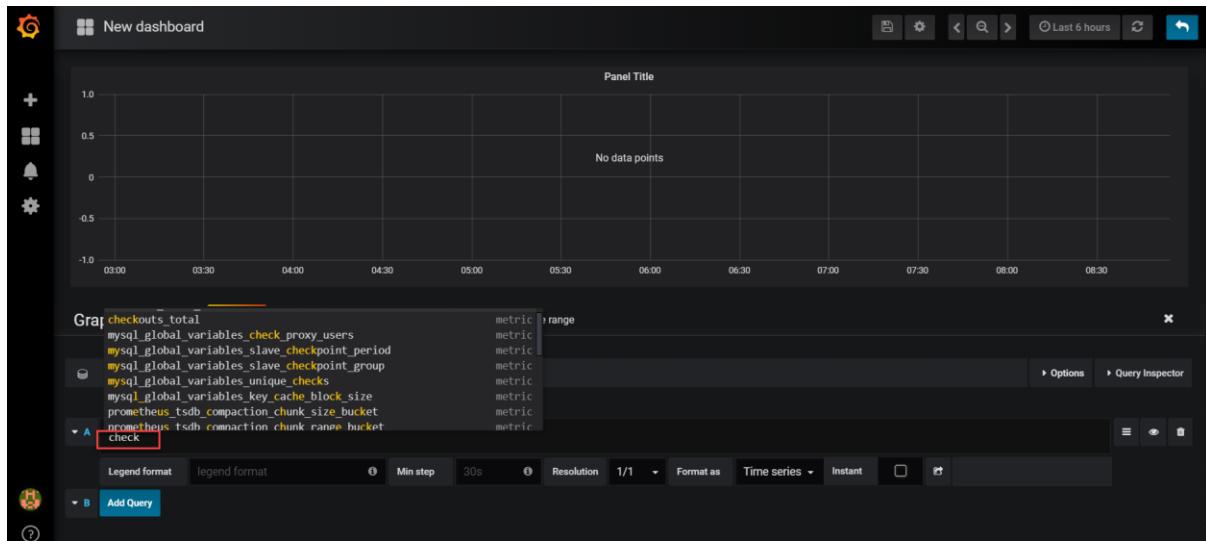


A new Panel with an initial graph appears. Click on Edit in the dropdown menu under Panel Title.



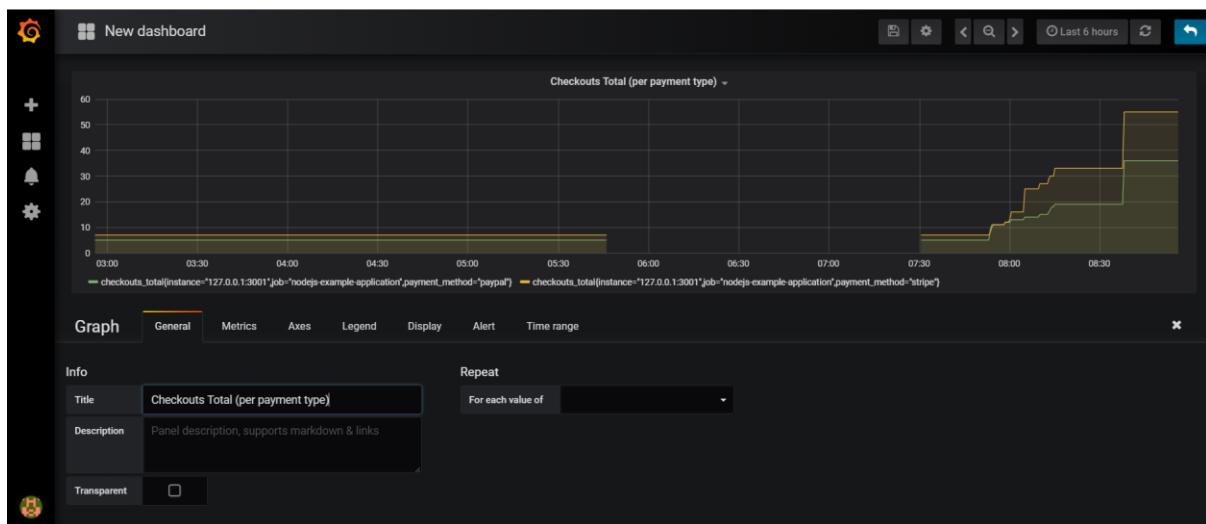
Set the Data Source for the Graph to Prometheus.

Then start typing the name of metric A. Type *check* and that should bring up a list of applicable metrics. Select *checkouts\_total*.



The graph will start to show.

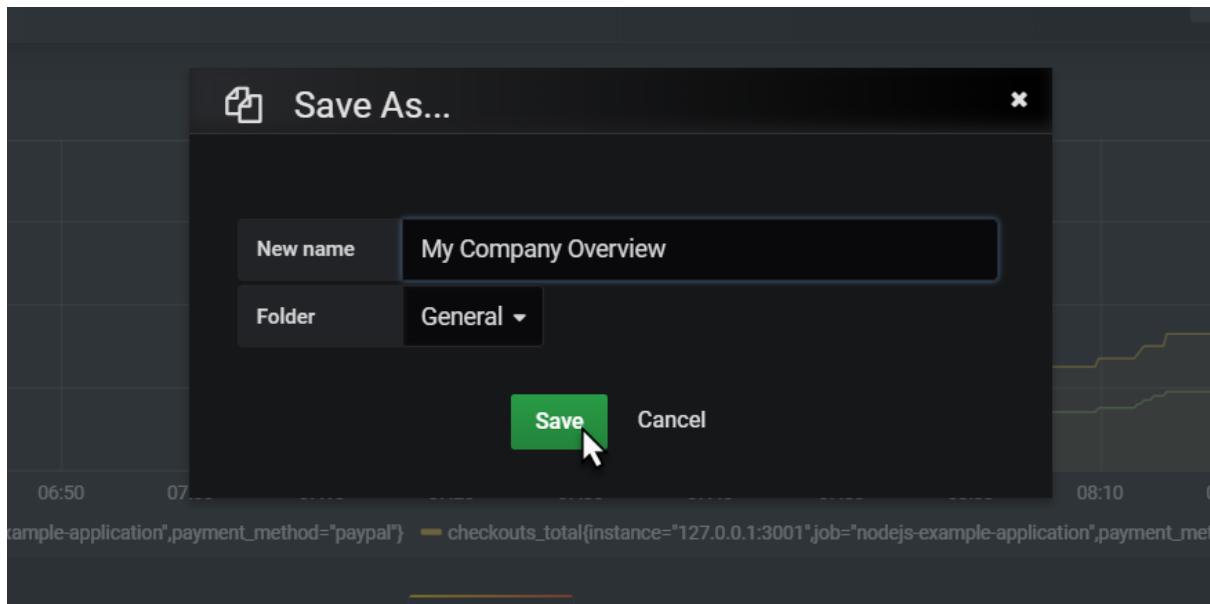
Switch to the General tab and update the title of the graph, for example to Checkout Total (per payment type):



Click on the save icon to save the current state of the dashboard.

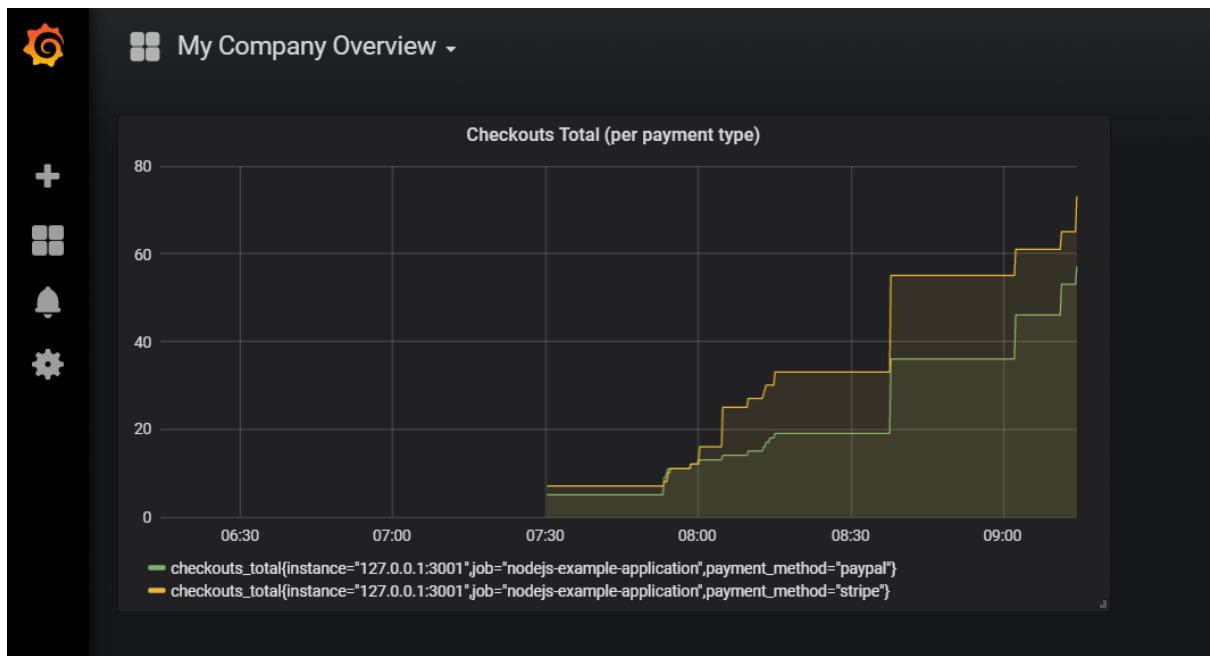


Provide a name for your dashboard



And click on Save.

You now may want to make some calls to <http://192.168.188.112:3001/checkout> to influence the `checkouts_total` metric that this dashboard is proudly visualizing. If you do so, this should result in a visible step in the chart. Because of a user action in a business application, and because that business application publishes Prometheus metrics, and because Prometheus periodically scrapes and process and stores those metrics and because Grafana periodically collects those stored data and visualizes them, we - with our Ops engineer hat on - are aware of that activity. And could respond to it.

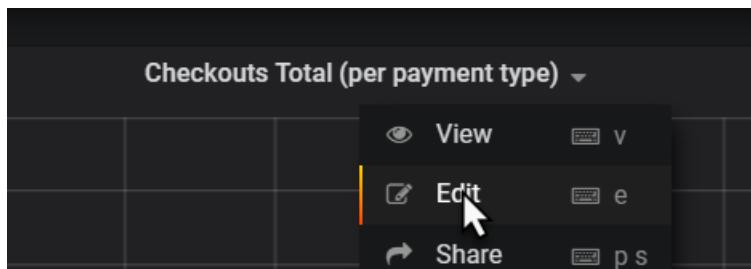


## Extend the Dashboard

Adding additional metrics in a graph is dead easy. They can come from the same or a different data source and they can be related or totally unrelated. And they can also be calculated using the expression engine in Grafana.

Add Sum of Checkout Totals [over all payment methods]

Click on the panel title for the graph. Click on *edit* in the dropdown menu:



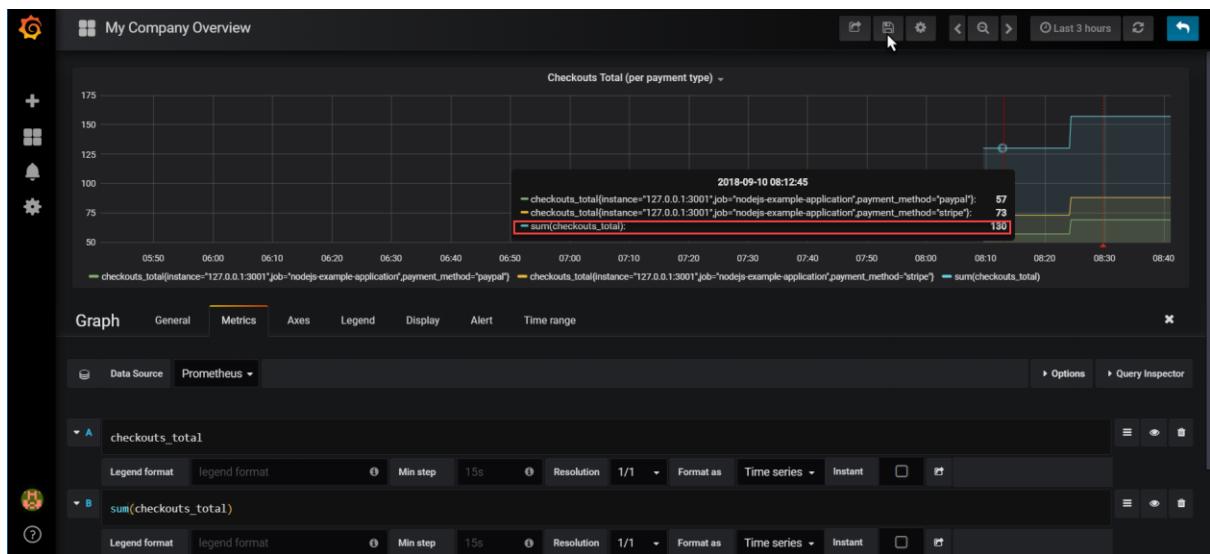
Switch to the metrics tab and click on *Add Query*

The screenshot shows the Grafana interface with the Metrics tab selected. At the top, there are tabs for Graph, General, Metrics, Axes, Legend, Display, Alert, and Time. Below the tabs, there is a Data Source selector set to Prometheus. A search bar labeled 'A' contains the query 'checkouts\_total'. Underneath the search bar are fields for 'Legend format' and 'Min step', with '15s' selected. At the bottom of the Metrics tab, there is a prominent blue button labeled 'B' with the text 'Add Query'.

Type `sum(ch` and select `checkouts_total` from the suggestion list:

The screenshot shows the Grafana Metrics editor interface. At the top, there are tabs: Graph, General, Metrics (which is selected), Axes, Legend, Display, Alert, and Time range. Below the tabs is a 'Data Source' dropdown set to 'Prometheus'. A dropdown menu is open over the metric 'sum(checkouts\_total)', showing options: 'function', 'metric', 'metric', 'metric', 'metric', 'metric', 'metric', and 'metric'. The 'metric' option is highlighted.

When you tab out of the field, the graph is immediately updated. It now shows the sum over all checkouts\_total values:



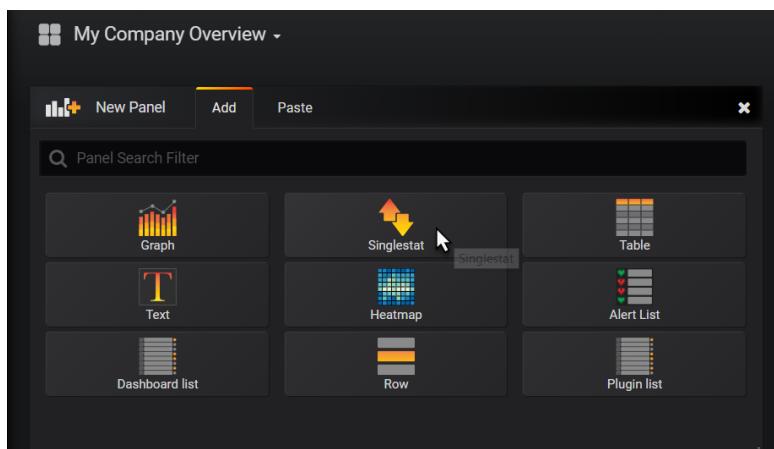
Click on the Save icon to save the updated dashboard definition.

### Add Panel to Show Current Value of Total of Checkout Totals

Grafana panels can be created for displaying one single value that needs to be highlighted.

As a quick example:

Add a panel, of type Single Stat.

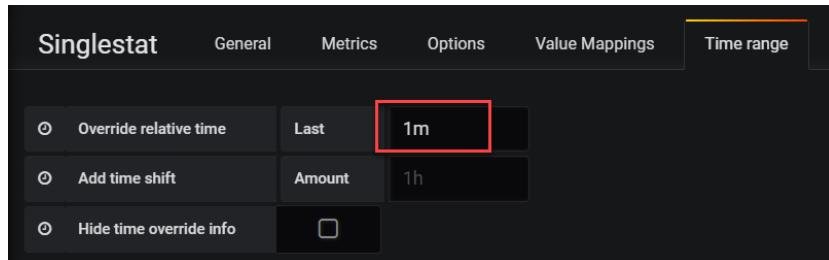


Click on Panel Title | Edit.

Switch to Metrics tab. Type

```
sum(checkouts_total)
```

Switch to *Time Range* tab. Set *override relative time* to 1m – to get only the most recent value for the sum.



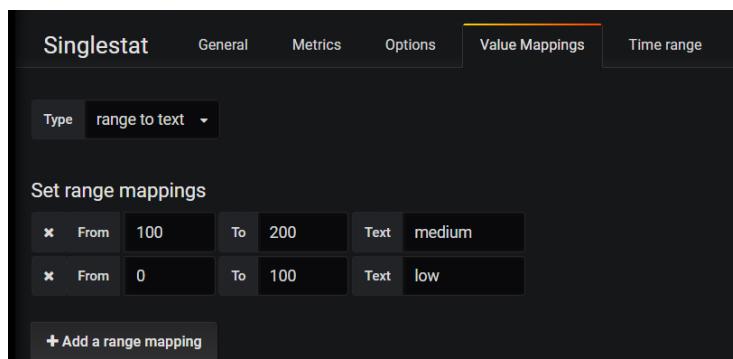
Switch to tab General and set a more meaningful title for the panel.

Save your changes and return to the dashboard.

Finally resize this panel to a more proper size.



Note: in the Single Stat panel editor is the Options tab where you can define display options – for example to associate special colors with values or value ranges. In the Value Mappings tab, you can define labels that should be displayed for specific value ranges – for example labels such as *low*, *medium*, *high* or *relax*, *watch out* and *go crazy*.



## Using the Alert Mechanism in Grafana

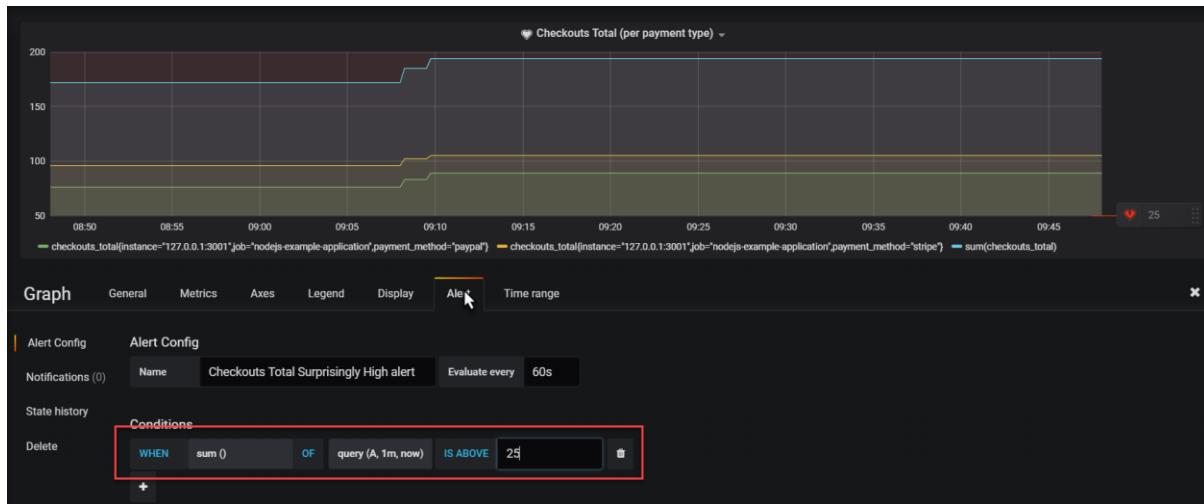
Grafana contains an alert mechanism, somewhat similar to that in Prometheus. Note: there is no direct connection to the Alertmanager or the Alert rules in Prometheus.

Alerts can be defined on panels. Click on the panel title for the checkout totals chart and open the panel editor.

Click on the Alert tab. Then click on Create Alert.

Define a name – for example *Checkouts Total Surprisingly High alert*. Then specify the alert condition – for example:

```
WHEN sum() OF query(A,1m,now) IS ABOVE 25
```



When you scroll down a little, you will find the Test Rule button. When you press this button, the rule is evaluated and info is shown:

```
firing: true
state: "alerting"
lastFiring: "true = true"
since: "113ms"
matches: Array[2]
  r0: Object
    metric: "checkouts_total(instance='127.0.0.1:3001', job='nodejs-example-application', payment_method='paypal')"
    value: 445
  r1: Object
    metric: "checkouts_total(instance='127.0.0.1:3001', job='nodejs-example-application', payment_method='stripe')"
    value: 525
logs: Array[3]
  r0: Object
    message: "Condition@0: Query Result"
    data: Array[2]
      r0: Object
        message: "Condition@0: Eval: true, Metric: checkouts_total(instance='127.0.0.1:3001', job='nodejs-example-application', payment_method='paypal'), Value: 445.000"
        data: null
      r1: Object
        message: "Condition@0: Eval: true, Metric: checkouts_total(instance='127.0.0.1:3001', job='nodejs-example-application', payment_method='stripe'), Value: 525.000"
        data: null
```

Save your changes and return to the dashboard.

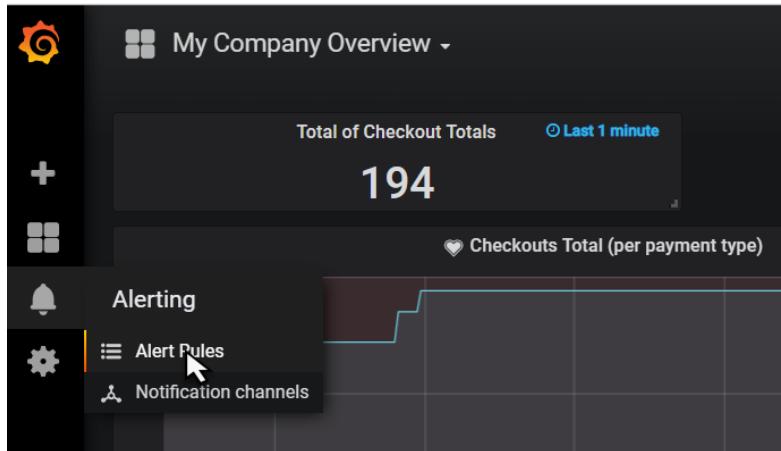
A little icon is shown on the Panel title to indicate that alerts have been defined for this panel.



When the alert is active, the heart icon will turn red. You may have to make a few more calls to the /checkout endpoint to make this alert fire.

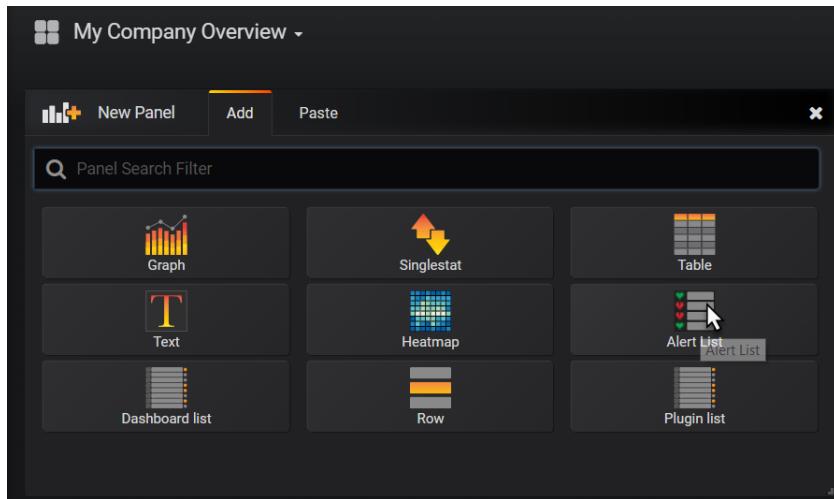
There are several ways to inspect a firing alert:

- drill down to the Panel editor
- check the Alert Rules option from the main dashboard menu

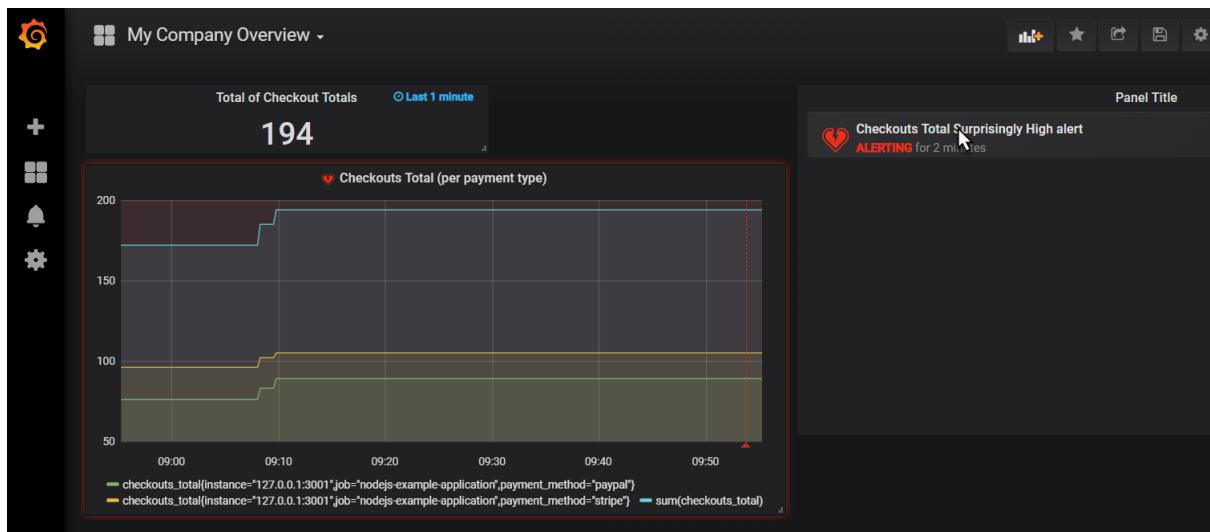


- add a panel of type Alert List

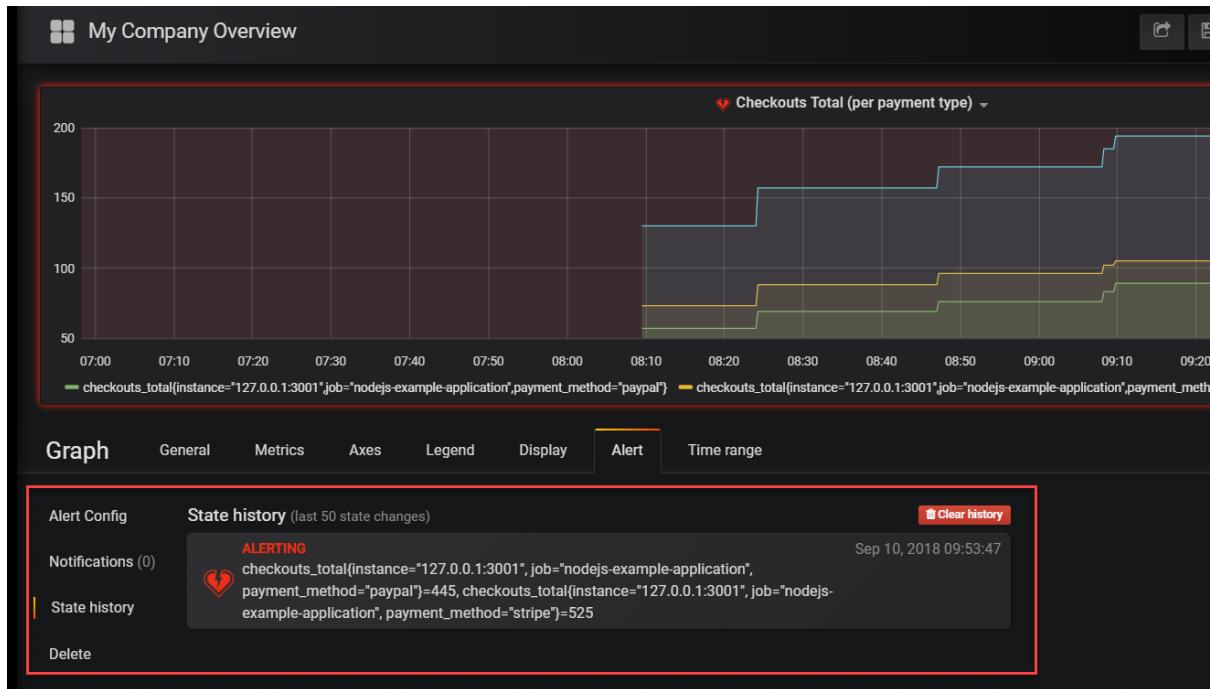
Do the latter:



And when the alert is firing, you will see this:



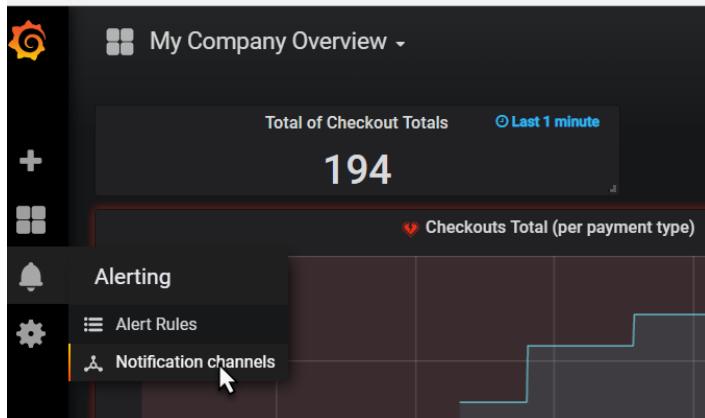
When you click on the active alert, you drill down to the alert definition in the panel editor:



Here you can inspect details and check the history of the alert.

Note: just like in the Prometheus Alert Manager, you can configure notification channels and associate them with the alerts.

The Notification Channels are set up from the Alerting | Notification Channels option on the main menu.



### Notify on Alerts from Grafana

Grafana has out of the box support for a substantial number of notification and communication channels:

The screenshot shows the Grafana Alerting interface. At the top, there's a bell icon and the title "Alerting" followed by the subtitle "Alert rules & notifications". Below this, there are two tabs: "Alert Rules" and "Notification channels", with "Notification channels" being the active tab. The main area is titled "New Notification Channel". It contains a form with the following fields:

- Name:** A text input field.
- Type:** A dropdown menu set to "Email". A list of other notification types is visible in a dropdown menu:
  - HipChat
  - Microsoft Teams
  - VictorOps
  - webhook
  - DingDing
  - Discord
  - Email
  - LINE
  - Telegram
  - Prometheus Alertmanager
  - Kafka REST Proxy
  - OpsGenie
  - PagerDuty
  - Pushover
  - Sensu
  - Slack
  - Threema Gateway
- Send on all alerts:** A checkbox with an information icon.
- Include image:** A checkbox with an information icon.
- Email addresses:** A text input field containing "You can enter multiple email".

At the bottom of the form are three buttons: "Save" (green), "Send Test" (blue), and "Back" (grey).

Feel free to configure the Slack notification channel – using the same Slack WebHook endpoint as before with the Prometheus alert manager – and make Grafana send notifications to Slack – or one of the other channels.