DATALOGGING MISSION CITY OF LORIENT, BRITTANY, FRANCE

HOWTO MONITOR AND DISPLAY A TEMPERATURE WITH A RASPBERRY PI

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1. Framework of the document

The city of Lorient is involved in the Interreg Europe EMPOWER program, which aims to develop energy monitoring systems and associated financial mechanisms to reduce the energy consumption of mid-sized buildings.



More information at: https://www.interregeurope.eu/empower/

As part of this energy monitoring policy, a mission to develop datalogging systems was initiated. This mission is carried out and developed by its environmental department.

The documentation presented here is used as a concept test. It allows to discover and explore a simple datalogging solution in order to verify its technical feasibility before carrying out an on-site deployment.

We will apply our case study to temperature monitoring: from installing an operating system on a Raspberry Pi, to visualizing the data on a monitoring software.

A strong emphasis has been placed on the use of open source software to ensure accessibility and reproducibility of the solution.

This procedure will be carried out in three steps:

- We will configure a Raspberry Pi and its operating system Raspbian.
- We will configure a DS18B20 temperature sensor on our Raspberry Pi to read, display, and record temperature measurements.
- We will install and configure monitoring tools, namely Zabbix and Grafana, to graphically monitor these temperatures.





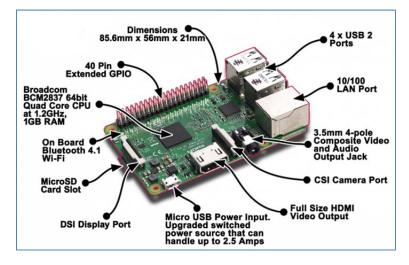
2. Install and configure a Raspberry Pi

This first part describes the installation and configuration steps of an operating system and additional administration tools required for a Raspberry Pi.

2.1. Overview of the Raspberry Pi

The Raspberry Pi is a tiny and affordable computer that you can use to learn programming through fun, practical projects. It is an ideal tool for the development of Do It Yourself projects in the areas of home-automation, multi-media, etc.

In this procedure, we will use a Raspberry Pi 3 Model B v1.2 de 2015 with a Quad-core ARM Cortex-A53 1.2 GHz and 1024Mo de RAM.



We will use the free and open source Raspbian operating system based on Debian GNU/Linux and optimized to run on a Raspberry Pi.



More information on the Raspberry Pi and how to purchase it at: https://www.raspberrypi.org/.

To perform this procedure, you will need:

- A Micro SD card and possibly a Micro SD card to SD card adapter plug.
- A Micro USB power supply (2.1 A).
- An Ethernet cable.

To use the Raspbian desktop (graphical user interface):

- An HDMI cable and a monitor.
- A keyboard and a mouse.





2.2. Installing Raspbian

2.2.1. Downloading Raspbian

Download an official version of Raspbian at <u>https://www.raspberrypi.org/downloads/</u> and select the image "Raspbian Stretch with desktop and recommended software" in.zip format.

	Raspbian Stretch with desktop and recommended software			Raspbian Stretch with desktop Image with desktop based on Debian Stretch		
Image with desk based on Debiar	top and recommended software I Stretch	0	Version: Release date:	November 2018 2018-11-13		
Version:	November 2018		Kernel version:	4.14		
Release date:	2018-11-13		Release notes:	Link		
Kernel version:	4.14		III Developed Tex	rent 😨 Download ZIP		
Release notes:	Link		Download for	P Download ZIP		
c		21652937ccde1c2583	re//dicaec40/12cd2	4037/d1530164/166438C		
539fdaf4e19ec7cebf9e61c049b82bs Raspbian S	45b1a21cdec91fa54bd59d660d2	21652937CODELC2553	re//dicaec40/12002	4032/d1290164/100498C		
539fdaf4e19ec7cebf9e61c049b82bs Raspbian S	45bla2lcdec91fa54bd59d660d2 Stretch Lite	21652937CCde1C2553	re//dicaec40/12002	923/41730764/106438C		
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2.2.2. Format your SD Card

For the next steps, you will need a computer with an SD card reader to write the Raspbian image to your Micro SD card.

It is a good idea to format your SD card before copying the installation files. Even, if it is brand new. The use of the formatting software developed by the SD Association is also recommended.

The software is available for Windows at: <u>https://www.sdcard.org/downloads/formatter_</u><u>4/eula_windows/index.html/</u>

Select the formatting options on « SD Card Formatter »:

SD Card Formatter	r	×
File Help		
Select card		
F:\		~
		Refresh
Card information		
Туре	SDHC	S)
Capacity	29.72 GB	
Formatting options		
O Quick format		
Overwrite format	>	
CHS format size ad	ljustment	
Volume label		
		Format
SD Logo SDH	C Logo and SDYC Logo a	re trademarks of SD-3C, LLC.
30 L0g0, 30H	c cogo ana 30XC cogo a	includending of 50-50, LLC.





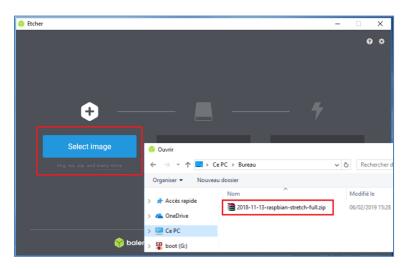
2.2.3. Burning Raspbian on the SD card

In order to prepare the Raspbian SD card, it is recommended to use the Etcher software available at: https://www.balena.io/etcher/.

Etcher is a free software developed with Electron (framework), for burning images (ZIP, img, iso) on different USB key media, SD Card, for GNU/Linux, Windows, MacOS. The application is portable and has a graphical interface.

Do this:

- -Download and install Etcher.
- Insert your Micro SD card into an SD card reader (may require a micro SD card to SD card _ adapter.
- Open Etcher and select from your hard drive the Raspbian.img or Raspbian.zip that you want to write on your SD card:



Select your SD card :

🛟 Etcher			- 🗆 X	7	
	Select a Drive. SDHC Card - 31.91 GB F: G:\ Continue		₽ ¢		
(balenaEtcher is an open source pro	ect by 🍞 balena	1.4.9		
Review your selected options your SD card.		Flash!	to start	writing Raspbian o	on
The procedure will go through	several steps:			Flash Complete!	
Starting C 15	5% Flashing 🔹	7% Validating	🥖 o 💉		





2.2.4. Enabling SSH access

Administering your Raspberry Pi remotely via SSH may be necessary if you want to use it as a "server". SSH or "Secure Shell" is a secure communication protocol.

The SSH server is disabled by default on Raspbian. To activate it, simply create an empty folder named "ssh" in the "boot" partition of your SD card. At the first start the file will be automatically detected by the system, the SSH server will be activated and the file will be deleted.

← → × ↑ 🕅 > bo	oot (G:)				
👆 Téléchargem 🖈 ^	Nom	Modifié le	Туре	Taille	
🗎 Documents 🖈	overlays	13/11/2018 13:08	Dossier de fichiers		
📰 Images 🛛 🖈	ssh	07/02/2019 09:08	Dossier de fichiers		
> 🙆 OneDrive	COPYING.linux	09/03/2018 18:28	Fichier LINUX	19 Ko	
/ Chebiwe	LICENCE.broadcom	09/03/2018 18:28	Fichier BROADCOM	2 Ko	
V 💻 Ce PC	bcm2708-rpi-0-w.dtb	19/09/2018 19:06	Fichier DTB	23 Ko	

We will see further in this procedure how to connect to a Raspberry Pi from a PC using Windows in SSH with the PuTTY utility program.

2.3. Taking control of your Raspberry Pi

2.3.1. First boot of your Raspberry Pi

At first boot, it is best to have a monitor with a HDMI connection, a keyboard and a mouse to run configurations using the graphical user interface.

A Raspberry Pi 3 Model B v1.2 powered up:







Caution
There is no "start" button on the Raspberry Pi. As soon as it is plugged in, Raspbian is executed.
In addition, it is strongly discouraged, in order not to corrupt the SD card and your data, to disconnect
the power supply when the Raspberry Pi is in use.
To switch it off correctly using the terminal, run the command:
sudo shutdown -h now
or
sudo halt
or if you use the graphical interface:
👹 Menu 😰 🖹 💻 🗰
Programming >
S Internet
Games >
Accessories >
Sraphics >
Office >
Help
Preferences >
د المراجع
Shutdown
You can then disconnect the Raspberry Pi.
1 ou can men disconnect the Rasporty 11.

At first boot, using the graphical user interface, you should see this screen:





At first boot, the default login is "pi", and the password is "raspberry". You should change it as soon as possible, leaving it, is a security vulnerability.

The "sudo" command allows you to launch a command as an administrator or otherwise named "root".

If you were not prompted to change it during first boot (see capture below) go to "Menu > Preferences > Raspberry Pi Configuration > System > Change User Password", and confirm. A window informs you that you will need to enter a new password for the user "pi":

Welcome to Raspberry Pi 🛛 🗕 🗖 🗙
Change Password
The default 'pi' user account currently has the password 'raspberry'. It is strongly recommended that you change this to a different password that only you know.
Enter new password:
Confirm new password:
☑ Hide characters
Press 'Next' to activate your new password.
Back

Alternatively, below, the password change window in the "Configuration" menu:

	Raspberry	Pi Configuratio	on >			
System	Interfaces	Performance	Localisation			
Password:			Change Password			
Hostname:		raspberrypi				
Boot:		⊙ To Desktop ○ To CLI				
Auto Login:		🗹 Login as user 'pi'				
Network at Bo	ot:	Wait for network				
Splash Screen	1:	💿 Enabled 🛛 🔘 Disab				
Resolution:			Set Resolution			
Underscan:		Enabled	Oisabled			
		Ca	ancel OK			





Next choose your location and language. Then, follow the rest of the instructions:

The Party of the P			
	Welcome to Raspberry	y Pi _ ×	
Set Country Enter the details time zone, keyb	of your location. This is use bard and other international	ed to set the language, settings.	
Country:	France	-	
Language:	French	•	
Timezone:	Paris	-	
		Use US keyboard	
	n you have made your sele	ction.	
Back		IVEXT	

2.3.2. Updating your Raspberry Pi

Your system is now configured. However, you should update it to minimize security breaches and bugs.

There are three elements to regularly update on a Raspberry Pi:

- Packages,
- The Distribution (Raspbian),
- The Firmware.

Updating these components requires an internet connection.

• Updating packages

sudo apt-	get update
sudo apt-	get upgrade

• Upgrading Raspbian

sudo apt-get dist-upgrade

• Updating the Firmware

Install the "rpi-update" utility software:

sudo	apt-get	update	
sudo	apt-get	install	rpi-update

Run the utility to perform the update:

sudo rpi-update

Reboot the system:

sudo reboot

• Miscellaneous: Git repository manager and I2C

Install the git command allows you to retrieve or synchronize source code on GitHub. It may be useful to you in future proceedings:

-								
ſ	su	do	apt-get	install	git			

Install tools to manage the I2C bus. There are many devices that use this I2C bus for home automation and electronics applications (e. g. temperature, humidity module, etc.):

 apt-get install i2c-tools

2.3.3. How to connect using SSH with PuTTY

First, check that the SSH connection is enabled.

To do this, you can open the Raspberry Pi Configuration utility in "Menu > Preferences > Raspberry Pi Configuration > Interfaces (tab)" and check the line "SSH: On".

🍯 Configuratio	on du Raspberr	y Pi		- • ×
Système	Interfaces	Performance	Localisation	
Caméra:			O Activé	 Désactivé
SSH:			 Activé 	○ Désactivé
SPI:			O Activé	 Désactivé
I2C:			 Activé 	O Désactivé
Série:			 Activé 	◯ Désactivé
1-Wire:			O Activé	 Désactivé
				Annuler Valider

Or, check its activation using the terminal:

To activate SSH from the terminal, run: sudo systemctl start ssh

On Windows, the use of a third-party program, such as PuTTY, available at <u>https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html/</u>, is required to initiate a SSH connection and execute command prompt.



It is necessary to know the IP address of your Raspberry Pi. You can obtain by running:

ifconfig		
or		
hostname -I		



On the PuTTY GUI, simply launch the connection using the "Open" button, then enter the user's name and password (by default on Raspbian the user is "pi" and his password is "raspberry").

If you have not changed your password at this point, do so, as your Raspberry Pi will be visible on your network and remotely accessible if another user knows the default password for a Raspberry Pi.

🧬 pi@raspberrypi: ~		—	
Using username "pi". Linux raspberrypi 4.14.97-v7+ #1197 SMP	🕵 PuTTY Configuration		? ×
The programs included with the Debian GN the exact distribution terms for each pr individual files in /usr/share/doc/*/cop Debian GNU/Linux comes with ABSOLUTELY N permitted by applicable law. Last login: Thu Feb 7 14:24:08 2019 fro SSH is enabled and the default password This is a security risk - please login a a new password. pi@raspberrvpi:~ \$ hostname -I 192.168.10.187 pi@raspberrvpi:~ \$ []	Category: Session Logging Terminal Keyboard Bell Features Window Appearance Behaviour Translation Selection Colours Connection Data Proxy Telnet Rlogin	Basic options for your PuTTY ses Specify the destination you want to connect Host Name (or IP address) 192.168.10.187 Connection type: Raw Telnet Rlogin SSH Load, save or delete a stored session Saved Sessions Default Settings	t to Port 22
Général Raccourci Compatibilité Sécurité Détails Versio	⊕- SSH Serial	Close window on exit: Always Never Only on cle	ean exit
Type de cible : Application Emplacement : PuTTY	About Help	Open	Cancel
Cible : iles\PuTTY\putty.exe" -ssh -pw rasp	berry pi@192.168.10.187		~

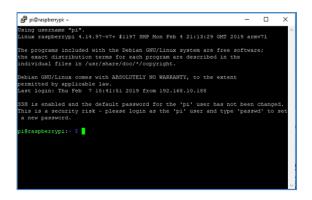
You can also create a PuTTY shortcut by changing the "target" in the shortcut property (see screenshot above).

Follow this template to create a shortcut: putty.exe" -ssh -pw user_password user_name@ip_adress

In our case:

putty.exe" -ssh -pw raspberry pi@192.168.10.187

When launching PuTTY from your PC under Windows, you should get a similar window:



It is now possible to remotely install packages or modify files using your PC to execute command prompt.





2.3.4. How to connect using FTP with FileZilla

It can be useful to remotely be able to drop or retrieve Python or PHP scripts and modify them in a text editor using FileZilla and the FTP Protocol.

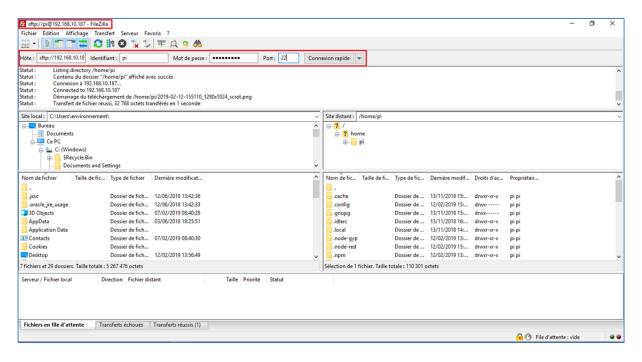
FileZilla Client is a FTP, FTPS and SFTP client, developed under the GNU General Public License. To download the client version of the program, go to: <u>https://filezilla-project.org/</u>.

Once installed and started, configure the connection like this:

- Host: the IP address of the Raspberry.
- Login: by default "pi".
- Password: the user's password "pi". By default "raspberry".
- Port: 22 (the SSH port).
- Press the "quick connect" button.

Note that your SSH connection must be enabled on Raspbian.

Once connected, you will find on the left the hierarchy tree of your PC and on the right the one of the Raspberry Pi.







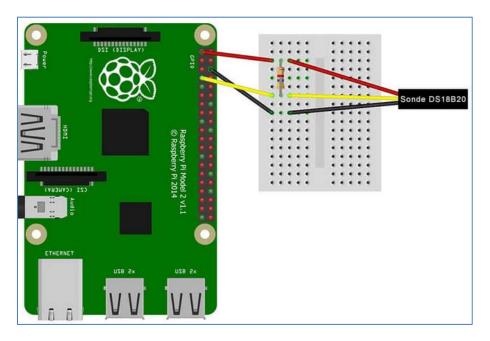
3. How to read a temperature with the DS18B20 sensor

This second part is aimed at installing and configuring a 1-Wire DS18B20 sensor to read and log a temperature.

3.1. Overview of the DS18B20 sensor

The DS18B20 is a digital temperature sensor communicating via a 1-Wire bus with a measuring range from -55°C to +125°C accuracy ± 0.5 °C between -10°C and +85°C.

The sensor is already pre-wired with resistance of 4.7 k Ω (yellow, purple, red) placed on the red and yellow wires. The sensor only has to be connected directly to the GPIO port of the Raspberry Pi according to the following diagram:



Below, a picture of the DS18B20 probe connected to a Raspberry Pi:





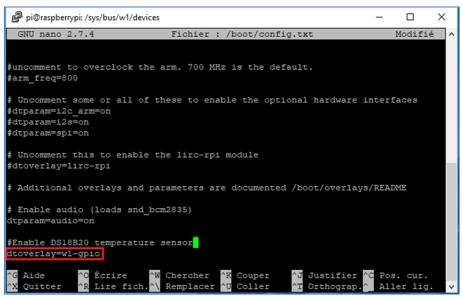
3.2. Configuring your Raspberry Pi

The sensor is not automatically recognized by the system. Before it can be used, it is necessary to configure the system to be able to communicate with it.

From your terminal, edit the file "/boot/config.txt":

sudo nano /boot/config.txt

Add the following lines at the end of the file: dtoverlay=w1-gpio



Save the file with "CTRL+W", and exit with "CTRL+X".

Reboot the system:

sudo reboot

To load the kernel modules required to use the sensor, run the following commands:

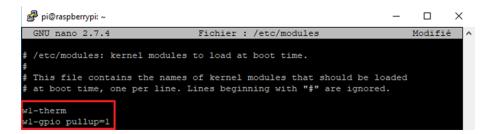
sudo modprobe	wl-therm
sudo modprobe	wl-gpio

In order for these modules to be automatically loaded at system boot, you must modify the following file "/etc/modules":

sudo nano /etc/modules

Add the two following lines at the end of the file:

```
wl-therm
wl-gpio pullup=1
```





3.3. First readings

To read a temperature in your terminal, simply go to the folder "/sys/bus/w1/devices/" and then look for the file starting with "28-*".

Move to the directory « /sys/bus/w1/devices »:

cd /sys/bus/w1/devices

To display the list of devices in this directory, run:

ls

pi@raspberrypi:~ \$ cd /sys/bus/wl/devices pi@raspberrypi:/sys/bus/wl/devices \$ ls 28-0516a4de4cff wl bus masterl

The serial number of your sensor should be displayed:

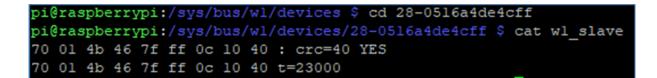
28-0516a4de4cff w1_bus_master1

To query this device, we must go to its directory. Change the X's by your own serial number:

cd 28-XXXXXXXXXXXXX

Then, run the command "cat" on the file "w1_slave". This command will simply read the contents of the file to you:

cat w1_slave



"YES" means that your Raspberry Pi can communicate with your sensor.

The temperature is expressed in Celsius degrees, multiplied by 1000. Here, the temperature is 23,000°C. It is represented as "t=23000" at the end of the file.



3.4. Display a temperature in a loop

Go back to the "root" directory:

cd

Create a new directory named "tempLog": mkdir tempLog

Move into the new directory and create a new Python file:

cd tempLog sudo nano getTemp.py

This program displays temperature readings on an SSH terminal. Remember to use the serial number of your sensor.

```
#SCRIPT TO RECOVER DATAS FROM THE DS18B20 TEMPERATURE PROBE
#DISPLAY THE TEMPERATURE IN CELSIUS DEGREE
# -*- coding: utf-8 -*-
#IMPORT ALL OF THE PYTHON LIBRARIES WE NEED
import os
import time
import datetime
import glob
from time import strftime
#LOAD THE GPIO AND THERM KERNELS AGAIN USING MODPROBE
os.system('modprobe w1-gpio')
os.system('modprobe w1-therm')
#GET OUR PROBE NUMBER STARTING WITH 28-*
temp_sensor = '/sys/bus/w1/devices/28-0516a4de4cff/w1_slave'
def tempRead():
           #READ IN THE w1 slave FILE USING open 'r'
        t = open(temp_sensor, 'r')
        lines = t.readlines()
        t.close()
        temp_output = lines[1].find('t=')
        if temp_output != -1:
                        #IF RETURNED VALUE IS -1, IT DID NOT FIND IT
                        #WITHOUT THE +2 YOU GET `T=XXXXX'
                temp_string = lines[1].strip()[temp_output+2:]
                temp_c = float(temp_string)/1000.0
        return round(temp_c,1)
while True:
   temp = tempRead()
   print temp
                                                                 ")
                                (time.strftime("%Y-%m-%d
   datetimeWrite
time.strftime("%H:%M:%S"))
   print datetimeWrite
      #CAN REMOVE BREAK AND INSERT TIME.SLEEP(60)
      #TO OUTPUT THE TEMP AND CURRENT DATE AND TIME EVERY MINUTE
   break
```



+

 \odot \odot

In the "tempLog" directory, run:

sudo python getTemp.py

You should see numbers displayed in your terminal "22.1" corresponding to a temperature in Celsius degrees and "2019-02-18 14:15:35" to a date:

Pi@raspberrypi: ~/tempLog	-	×
pi@raspberrypi:~/tempLog \$ sudo python getTemp.py 22.1 2019-02-18 14:15:35		^
pi@raspberrypi:~/tempLog \$		

3.5. Log a temperature in a database

3.5.1. Installing a LAMP server

To log our temperature values, we will need a database using MySQL. To access the database online, we will need a web server and a programming language to run it, Apache and PHP respectively. Therefore, we will use a LAMP architecture.



LAMP is an acronym for Linux, Apache, MySQL, and PHP. It is a software stack that includes the operating system, an HTTP server, a database management system and an interpreted programming language, and allows you to set up a web server.

• Installing Apache

Check that your Raspbian is up to date:

sudo apt update
sudo apt upgrade

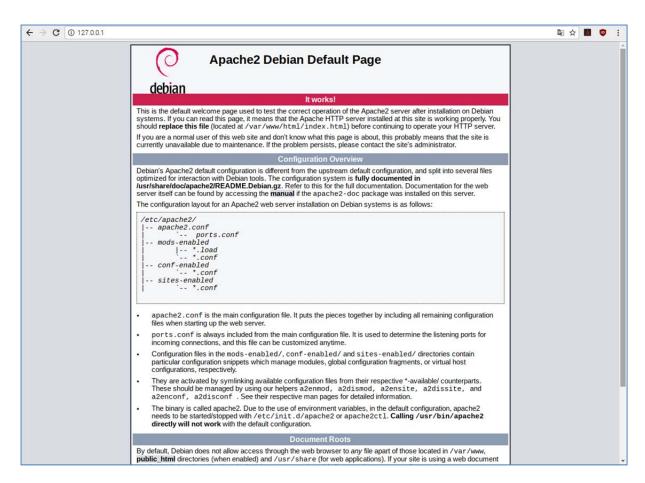
To install Apache, run the following command. When prompted, type "y": sudo apt install apache2

Give rights to the apache folder that will allow you to administer the sites. To do this, run the following commands:

sudo chown	-R pi:www-data /var/www/html/
sudo chmod	-R 770 /var/www/html/

Once the installation is complete, make sure that Apache is working properly by going to "http://127.0.0.1" from your Raspberry Pi browser. You should get a page with the following message: "It works!".





Alternatively, you can run the following command in your terminal: wget -0 verif_apache.html http://127.0.0.1

This command will save the HTML code of the page in the "verif_apache.html" file in the current directory. Then, read the file:

cat ./verif_apache.html

If you see "It works!" displayed in the code, it means that Apache is working.

• Installing PHP

Update PHP and its packages by running:

apt-get install php*cli

sudo apt install php-curl php-gd php-intl php-json php-mbstring
php-xml php-zip

To check if PHP is working, delete the "index.html" in the directory "/var/www/html": sudo rm /var/www/html/index.html

Then create a new "index.html" in the same directory: echo "<?php phpinfo(); ?>" > /var/www/html/index.php



.1		Se 🛧 📕	•
PHP Version 7.0.33-0+deb9u1	Php		
System	Linux raspberrypi 4,14,97-v7+ #1197 SMP Mon Feb 4 21:13:29 GMT 2019 armv7l		
Build Date	Dec 7 2018 11:36:49		
Server API	Apache 2.0 Handler		
Virtual Directory Support	disabled		
Configuration File (php.ini) Path	/etc/php/7.0/apache2		
Loaded Configuration File	/etc/php/7.0/apache2/php.ini		
Scan this dir for additional .ini files	/etc/php/7 0/apache2/conf.d		
Additional .ini files parsed	ketophp/7.04pache2/contd10-mysqlnd ini, ketophp/7.04pache2/contd10-opcache ini, ketophp/7.04pache2/contd10-opcache ini, ketophp/7.04pache2/contd10-opcache ini, ketophp/7.04pache2/contd12-opcache ini, ketophp/7.04pache2/contd12-opcache2/contd		
PHP API	20151012		
PHP Extension	20151012 320151012		
Zend Extension Zend Extension Build	320151012 API320151012.NTS		
PHP Extension Build	API320151012,NTS		
Debug Build	R0		
Thread Safety	disabled		
Zend Signal Handling	disabled		
Zend Signal Handling Zend Memory Manager	enabled		
Zend Multibyte Support	provided by mbstring		
IPv6 Support	enabled		
DTrace Support	available, disabled		
D made Support	LET WILLING AND AND A DECEMBER OF A DECEMBER		

Using your Raspberry's browser, at the address "http://127.0.0.1", you should get the page below:

• Installing MySQL

In order to log our temperature measurements we will have to set up a DBMS (Database Management System), namely MySQL.

Install MySQL with the following command. Enter "y" when prompted:

sudo apt install mysql-server php-mysql

A prompt appears asking you to enter a password for the MySQL database. Memorize it.

At some point we will edit our MySQL database from a Python script, so download the corresponding Python library:

sudo apt-get install python-mysqldb

• Creating a databse using MySQL

Launch MySQL: sudo mysql -u -p

This connects us to MySQL as a "root" user (-u) and asks us for a password (-p). Enter the password you previously created for MySQL.



We will now delete the "root" user (DROP USER) and create a new "root" user (CREATE USER), because the default one is only usable by the system administrator account, and is therefore not accessible to PHP scripts on the server. We then grant it all the privileges (GRANT ALL PRIVILEGES) on all databases (*.*).

DROP USER 'root'@'localhost';								
CREATE USER 'root'@'localhost' IDENTIFIED BY 'password';								
GRANT ALL PRIVILEGES ON *.* TO 'root'@'localhost';								

The next time you connect, use the command:

mysql --user=root --password=yourpassword

We will now create a new database: CREATE DATABASE temp_database;

Check if the database was successfully created:

SHOW DATABASES;

A list of databases currently hosted by MySQL is displayed.

We want to create a new table in the "temp_database" database. To do this, we must first tell MySQL that we want to use the "temp_database" database:

USE temp_database;

We want to create a table in MySQL with two non-null fields: "datetime" (DATETIME type) and "temperature" (FLOAT type):

CREATE	TABLE	tempLog(datetime	DATETIME	NOT	NULL,	temperature
FLOAT(5	,2) NOT	NULL);				

```
🧬 pi@raspberrypi: ~
                                                                                             ×
oi@raspberrypi:~
                 $ sudo mysql --user=root
                                            --password=password
Welcome to the MariaDB monitor. Commands end with ; or g.
Your MariaDB connection id is 9
Server version: 10.1.37-MariaDB-0+deb9ul Raspbian 9.0
Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
MariaDB [(none)]> CREATE DATABASE temp_database;
Query OK, 1 row affected (0.00 sec)
MariaDB [(none)]> SHOW DATABASES;
 Database
 information_schema
 mysql
 performance schema |
 temp_database
4 rows in set (0.01 sec)
MariaDB [(none)]> USE temp_database;
Database changed
MariaDB [temp_database]> CREATE TABLE tempLog(datetime DATETIME NOT NULL, temper ature FLOAT(5,2) NOT NULL);
Query OK, 0 rows affected (0.06 sec)
```



Check if the table was successfully created:

DESCRIBE tempLog;

ariaDB [temp	_database]> DB								
Field	Type				I E	xtra	I		
datetime	datetime float(5,2)		+ 	NULL NULL	+ 		-+ 		

Exit MySQL with "CTRL+Z".

• Installing phpMyAdmin

PhpMyAdmin is a web-based management application for MySQL DBMS that allows you to easily manage the content of your databases, without having to write your own SQL queries.

To install it, run:	
sudo apt install phpmyadmin	

During the installation of phpMyAdmin, you will be asked several questions about its settings. As we have already configured the database, choose "no" when asked about using "dbconfig-common". Choose to use phpMyAdmin for an Apache server. For the "root" password, it is the one you used for MySQL.

You can now access phpMyAdmin and your databases from your browser by going to "127.0.0.0.1/phpmyadmin/":

If an error is displayed, it may be due to the fact that phpMyAdmin is installed in the wrong folder. In this case, run the following command:

sudo ln -s /usr/share/phpmyadmin /var/www/html/phpmyadmin

phpMyAdmin 企画。② ③ ③ Récentes Préférées	🗕 🛋 Serveur	localhost 3306	o 🎯 Base de dor	nnées: temp_c	latabase » 🚮 Table:	tempLog					
	Afficher	M Structure	SQL	Rechercl	ner 📑 Insérer	Export	🛃 Import	Privilèges	🥜 Opérations	38 Dé	clencheur
	M Structu	re de table	්ක Vue relatio	nnelle							
Le Nouvelle base de données	# Nom	Туре	Interclasseme	nt Attributs I	Null Valeur par défaut	Commenta	aires Extra Ac	tion			
mysql mysql mysql m performance_schema	📄 1 dateti	me datetime		1	Ion Aucune		0	Modifier 🥥 Suppri	mer 🤌 Primaire 🔟 🗢 plus	Unique 📒	Index
temp_database	🖂 2 temp	erature float(5,2)		1	lon Aucune		60	Modifier 🤤 Suppri	ner 🤌 Primaire 👿 🗢 plus	Unique 😕] Index



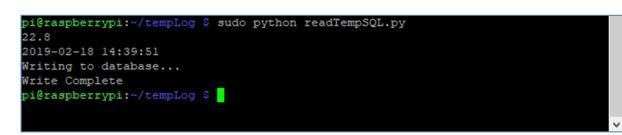
Let's rework our previous Python script in order to write the date and temperature in our MySQL database "temp_database". Go to the "tempLog" directory and create the script "readTempSQL.py": #SCRIPT TO WRITE DATE AND TEMPERATURE IN MYSQL DB

```
#!/usr/bin/env python
import os
import time
import datetime
import glob
import MySQLdb
from time import strftime
os.system('modprobe w1-gpio')
os.system('modprobe w1-therm')
temp_sensor = '/sys/bus/w1/devices/28-0516a4de4cff/w1_slave'
# VARIABLES FOR MYSQL
db = MySQLdb.connect(host="localhost", user="root",passwd="password",
db="temp database")
cur = db.cursor()
def tempRead():
    t = open(temp_sensor, 'r')
    lines = t.readlines()
    t.close()
    temp_output = lines[1].find('t=')
    if temp output != -1:
        temp_string = lines[1].strip()[temp_output+2:]
        temp_c = float(temp_string)/1000.0
    return round(temp c,1)
while True:
    temp = tempRead()
    print temp
                                                                ")
    datetimeWrite
                               (time.strftime("%Y-%m-%d
                                                                         +
                        -
time.strftime("%H:%M:%S"))
    print datetimeWrite
     # SQL QUERY TO INSERT DATA INTO THE TABLE
        = ("""INSERT INTO tempLog (datetime,temperature)
    sql
                                                                   VALUES
(%s,%s)""",(datetimeWrite,temp))
    try:
        print "Writing to database..."
           # RUN THE SQL COMMAND
        cur.execute(*sql)
        # COMMIT YOUR CHANGES INTO THE DATABASE
        db.commit()
       print "Write Complete"
    except:
        # ROLLBACK IF ANY ERROR
        db.rollback()
       print "Failed writing to database"
    cur.close()
    db.close()
    break
```



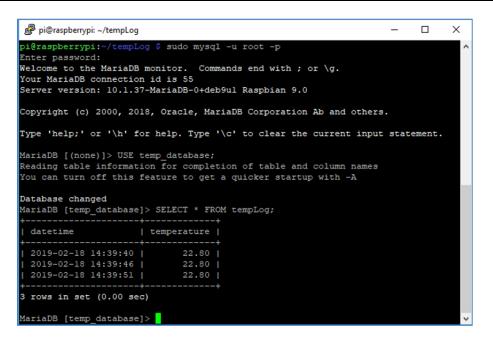
The variables that are used to communicate with MySQL (password, user, host, etc.) lines 11 and 12 and the SQL query to insert data into the database lines 32 and 33 must be adapted to your situation.

Launch the script several times to write measurements into your database: sudo python readTempSQL.py



Check the "tempLog" table for data:

USE temp_database; SELECT * FROM tempLog;



Alternatively, check it on phpMyAdmin:

Afficher Structure Solut 4 Rechercher Afficher Structure Solut 4 Rechercher Afficher Solut 4 Rechercher Solut 4 Inseierr Inseierr Inseierr	phpMyAdmin	- 👘 Serveur loo	:alhost 3305 = 👩 B	rse de données	temp_databa	se = 🚮 Tab	le templi	29								1
A Nouvelle base de donnes Profilage [Éditer en ligne] [Modifier] [Exployer SQL] [Créer code source PHP] [Opions determent un gene la genes 25 * Filtrer les lignes: Chercher dans cette table		Afficher	Structure	SQL 🔍	Rechercher	≩é Insén	w 🔜	Export	Import		Privilèges	8	Opérations	25	Décler	che
if Nouvelle base de données if Nouvelle base de données if Nouvelle base de données prodimance achema if nouvelle base de données if Nouvelle base de données <																_
vooren use be donkes vooren use be do		🔥 La sélection d	courante ne contien	pas de colonn	e unique. Les ç	rilles d'édit	ion, les ca	ises à cochi	r ainsi que	les lier	s Edition, C	opie e	t Supprimer n	e sont	pas disp	ponib
mysql • Affichage des lignes 0 - 2 (total de 3, Traitement en 0.0009 secondes.) performance_schema impediatable vendetable	Nouvelle base de données		•													
performance_schema Sitter * rise* 'temptop' temp diabase Profilage [Éditer en ligne] [Modifier] [Expliquer SQL] [Crier code source PHP]].	information_schema	Comparison of the owner of the														
Itemp database Profilage [Éditer en ligne] [Modifier] [Exployer SQL] [Crier code source PHP]].	mysql	Affichage des	Affichage des lignes 0 - 2 (total de 3, Traitement en 0.0009 secondes.)													
Wouvelle table Profilage [Editer on Igner] [Modifier] [Exployer SQL] [Crien code source PHP] [Tout afficher Nombre de Ignes 25 • Filter les Ignes: Chercher dans cette table Options determe temperature 2019-02-18 14:39:46 22:80 2019/02-18 14:39:46 22:80	j performance_schema	SELECT * FROM	tempLog"													
Chercher dans cette table Copions datetime temperature 2019402-18 14 39:46 22.80		Contraction Contraction									-					
Characterize Nombre de lignes 25 Fitzer les lignes. Chercher dans cette table Options datetime z019402-18 14:39:40 22.80 2019402-18 14:39:46 Z2.80							Profilage	Editer en l	gne] [Mod	inter][Expliquer S	QL][Créer code so	urce P	Hb][1	ictus
date/ime temperature 2019-02-18 14.39-40 22.80 2019-02-18 14.39-46 22.80	+ tempLog	Tout affich	er Nombre de lig	nes : 25 •	Filtrer le	s lignes:	Chercher d	ians cette ta	ble							
date/ime temperature 2019-02-18 14:39-40 22.80 2019-02-18 14:39-46 22.80		-														
2019-02-18 14 39 40 22 80 2019-02-18 14 39 46 22 80		+ Options														
2019-02-18 14:39:46 22.80		datetime	temperature													
		2019-02-18 14:39:4														
2019-02-18 14 39 51 22 80																
		2019-02-18 14:39:5	22.80													
Tout afficher Nombre de lignes: 25 • Filtrer les lignes: Chercher dans cette table																



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3.6. Scheduling an automatic reading

If we want our script to automatically record a temperature reading in the database every T minutes, we will use Crontab, which is a unix task scheduling tool.

To open Crontab from the "root" directory, run: sudo crontab -e

Add the following line at the end of the Crontab file:

*/5 * * * * /home/pi/tempLog/readTempSQL.py

It simply executes our Python script every 5 minutes. If you have used different file and folder names, change the line accordingly. Replace "5" with "X", the number of minutes between two temperature readings.

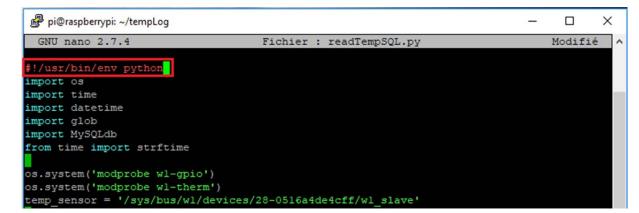
₽i@raspberrypi: ~	-		×
GNU nano 2.7.4 Fichier : /tmp/crontab.r24scL/crontab		Modifi	é ^
$\frac{1}{2}$ Edit this file to introduce tasks to be r_{a} by cron.			
# Each task to run has to be defined through a single line # indicating with different fields when the task will be run # and what command to run for the task			
<pre># # To define the time you can provide concrete values for # minute (m), hour (h), day of month (dom), month (mon), # and day of week (dow) or use '*' in these fields (for 'any').# # Notice that tasks will be started based on the cron's system # daemon's notion of time and timezones.</pre>			
<pre># # Output of the crontab jobs (including errors) is sent through # email to the user the crontab file belongs to (unless redirected). #</pre>			
<pre># For example, you can run a backup of all your user accounts # at 5 a.m every week with: # 0 5 * * 1 tar -zcf /var/backups/home.tgz /home/</pre>			
<pre># # For more information see the manual pages of crontab(5) and cron(8) # # m h dom mon dow command</pre>			
<pre># m dom mon dow command */5 * * * * /home/pi/tempLog/readTempSQL.py</pre>			
	os. c		
^X Quitter ^R Lire fich. ^\ Remplacer ^U Coller ^T Orthograp. ^ A	ller	lig.	~

As it stands, auto-registration will not work because the script "readTempSQL.py" is not yet executable and the Cronjob will fail.

cd /home	e/pi/tempLog	
sudo nar	no readTempSQL.py	

To make the script executable, you must first add a line to the "readTempSQL.py" file: #!/usr/bin/env python



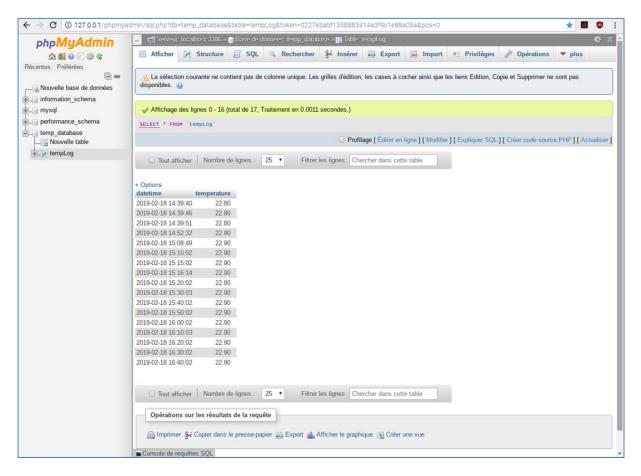


Then, you need to change the authorization of the file "readTempSQL.py" in order to make it executable ("+x" on Linux):

sudo chmod +x readTempSQL.py

To test that the file is now executable, navigate to your "tempLog" directory and run: ./readTempSQL.py

The file is now executable. Check your database on phpMyAdmin after 10 minutes to make sure your Cronjob is working.





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3.7. Exporting data in a JSON file

Let's create a PHP script to export the data from our database to a file. Go to the directory "/var/www/html" and create a new file "temperaturejson.php":

cd /var/www/html

```
sudo nano temperaturejson.php
```

```
<?php
//STORE INFOS INTO VARIABLES
       = 'localhost';
Shost
// SQL DB NAME
       = 'temp_database';
$db
// CONNECT TO THE DB
       = 'root';
$user
        = 'password';
$pass
$charset = 'utf8';
// LOGIN PROTOCOL USING PDO FORMAT
$dsn = "mysql:host=$host;dbname=$db;charset=$charset";
$opt = [
        PDO::ATTR_ERRMODE
                                     => PDO::ERRMODE EXCEPTION,
        PDO::ATTR_DEFAULT_FETCH_MODE => PDO::FETCH_ASSOC,
        PDO::ATTR_EMULATE_PREPARES
                                    => false,
        ];
$dbh = new PDO($dsn, $user, $pass, $opt);
// SQL QUERY TO READ ALL DATA FROM THE templog TABLE
$sql = $dbh->query("SELECT * FROM tempLog");
$rows = array();
while ($row = $sql->fetchall()) {
    $rows[] = $row;
}
//RETURN DATA IN JSON FORMAT
echo json_encode($rows);
?>
```

This PHP script retrieves all the data from the "tempLog" table from our "temp_database" database with the query "SELECT * FROM tempLog" and writes them into a table each time a set of "datetime" and "temperature" data is read. This aggregator table is then encoded in JSON and displayed using "echo".

To run the script and display its result, from your browser go to "http://hostanme/temperaturejson.php". Use your own IP address. You can obtain it with the command "hostame -I"

You should get a similar result:

← → C ③ 192.168.10.187/temperaturejson.php	*		۳	:
14:52:32","temperature":22.9}, {"datetime":"2019-02-18 15:08:49","ten 15:15:02","temperature":22.9}, {"datetime":"2019-02-18 15:16:14","ten 15:30:03","temperature":22.9}, {"datetime":"2019-02-18 15:40:02","ten	2019-02-18 14:39:46", "temperature":22.8}, {"datetime":"2019-02-18 14:39:51", "temperature":22.8}, {"datetime": perature":22.9}, {"datetime":"2019-02-18 15:10:02", "temperature":22.9}, {"datetime":"2019-02-18 perature":22.9}, {"datetime":"2019-02-18 15:20:02", "temperature":22.9}, {"datetime":"2019-02-18 perature":22.9}, {"datetime":"2019-02-18 15:50:02", "temperature":22.9}, {"datetime":"2019-02-18 perature":22.9}, {"datetime":"2019-02-18 16:20:02", "temperature":22.9}, {"datetime":"2019-02-18 perature":22.9}, {"datetime":"2019-02-18 16:20:02", "temperature":22.9}, {"datetime":"2019-02-18	:"2019	9-02-	18





4. How to monitor a temperature with Zabbix and Grafana

This third part describes the steps for installing, configuring and interfacing Zabbix and Grafana on Raspbian to monitor a temperature.

4.1. Framework

We now want to monitor and graphically display our temperature readings measured by a DS18B20 probe connected to a Raspberry Pi.

The readings are, at this stage, registered every 10 minutes in a MySQL database hosted by our Raspberry Pi on which we have installed and configured a LAMP server.

To carry out this monitoring, we will use the Zabbix software and its components. We will also use Grafana software for the graphical quality of its dashboards on which we will import several types of data sources (Zabbix, MySQL, etc.). An interface between Zabbix and Grafana must be configured.



Zabbix is a free software that monitors the status of various network services, servers and other network hardware and produces dynamic resource consumption graphs.



Grafana is a free software under Apache 2.0 license that allows the visualization and formatting of metric data. It allows you to create dashboards and graphs from several sources including time series databases such as Graphite, InfluxDB and OpenTSDB.



4.2. Installing and configuring Zabbix

4.2.1. Installing Zabbix and its components

• Installing Zabbix

Run the following commands to install Zabbix from its repository:

```
sudo wget
https://repo.zabbix.com/zabbix/4.0/raspbian/pool/main/z/zabbix-
release/zabbix-release_4.0-2+stretch_all.deb
sudo dpkg -i zabbix-release_4.0-2+stretch_all.deb
sudo apt update
sudo apt upgrade
```

• Installing components

Install the server, frontend, agent components for Zabbix:

```
sudo apt -y install zabbix-server-mysql zabbix-frontend-php zabbix-
agent
```

Nota Bene:

In this procedure, the Zabbix server and Zabbix agent components will be installed on the same Raspberry Pi. If the server and the Zabbix agent are running on the same machine, it is recommended to use a different user to run the server and the agent. Otherwise, if both are executed by the same user, the agent can access the server configuration file and any administrator-level user in Zabbix can very easily recover, for example, the database password.

• Créer une base de données pour Zabbix

Access MySQL:

mysql -uroot -p

Enter your « *root* » password.

Run the following MySQL commands to create a database named zabbix and grant access privileges to the zabbix user. The zabbix user was automatically created during the installation of Zabbix:

CREATE DATABASE zabbix CHARACTER SET utf8 COLLATE utf8_bin;

GRANT ALL PRIVILEGES ON zabbix.* TO zabbix@localhost IDENTIFIED BY 'password';

QUIT;





• Manage user privileges for MySQL (optional)

In case the command to grant privileges to the user "zabbix" by "root" does not work and displays an error message (see capture below) you can perform the procedure described in this section.

Welcome to the MariaDB monitor. Commands end with ; or \g.
Your MariaDB connection id is 51
Server version: 10.1.37-MariaDB-0+deb9ul Raspbian 9.0
Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
MariaDB [(none)]> create database zabbix character set utf8 collate utf8_bin; Query OK, 1 row affected (0.01 sec)
MariaDB [(none)]> grant all privileges on zabbix.* to zabbix@localhost identifie d by 'password';
ERROR 1044 (42000): Access denied for user 'root'@'localhost' to database 'zabbi
x'
MariaDB [(none)]>

Force MySQL update:

Access MySQL:

mysql -uroot -p

Check that the "root" user is able to grant privileges to other users: SELECT * FROM mysql.user WHERE User='root'\G;

MariaDB [(none)]> SELEC	<pre>r * FROM mysql.user WHERE User='root'\G;</pre>
*******	**** 1. row ***********************************
	localhost
User:	
Password:	*2470C0C06DEE42FD1618BB99005ADCA2EC9D1E19
Select_priv:	
Insert_priv:	Y
Update_priv:	Y
Delete_priv:	Y
Create_priv:	Y
Drop_priv:	Y
Reload priv:	Y
Shutdown priv:	Y
Process priv:	Y
File priv:	Y
Grant priv:	N
References priv:	Y
Index priv:	Y
Alter priv:	Y
Show db priv:	Y
Super priv:	
Create tmp table priv:	Y
Lock tables priv:	Y
Execute priv:	У
Repl slave priv:	Y
Repl client priv:	Y
Create view priv:	Y
Show view priv:	Y
Create routine priv:	Y
Alter routine priv:	
	17

Alternatively, execute the SQL command displaying the privilege status for all users: SELECT host, user, password, Grant_priv, Super_priv FROM mysql.user;

host	user	password	Grant_priv	Super_priv
localhost		*2470C0C06DEE42FD1618BB99005ADCA2EC9D1E19	N	Y
%		*2470C0C06DEE42FD1618BB99005ADCA2EC9D1E19	N	N

On the two previous screenshots, we notice that the "root" administrator user is not able to grant access privileges to other users (Super_priv: N).



Run the following SQL commands to fix this:

UPDATE	mysql.user	SET	Grant_priv='Y',	Super_priv='Y'	WHERE
User='	root';				
FLUSH	PRIVILEGES				
SELECT	host,user,pas	sword,	Grant_priv,Super_	_priv FROM mysql.us	er;

Then, check again. It may be necessary to exit and restart MySQL to ensure that the new configuration is properly taken into account.

<pre>MariaDB [(none)]> UPDATE mysql.user SET Grant_priv='Y', Super_priv='Y' WHERE User='root'; Query OK, 1 row affected (0.00 sec) Rows matched: 1 Changed: 1 Warnings: 0 MariaDB [(none)]> SELECT host, user, password, Grant_priv, Super_priv FROM mysql.user; ++</pre>								
host	user	password	Grant_priv	Super_priv				
localhost %		<pre>*2470C0C06DEE42FD1618BB99005ADCA2EC9D1E19 *2470C0C06DEE42FD1618BB99005ADCA2EC9D1E19</pre>		+				
++ 2 rows in set (0.00 sec)								

To ensure that the root user has full privileges on all MySQL databases (" *") and covering all host types (" %"), run the SQL command:

GRANT ALL PRIVILEGES ON *.* TO root@'%' IDENTIFIED BY 'password';

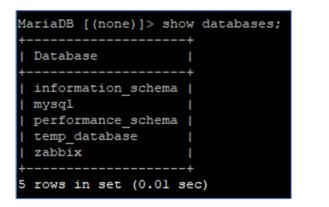
Restart MySQL and run: GRANT ALL ON zabbix.* TO zabbix@localhost IDENTIFIED BY 'password';





• Checking the database

You can check the creation of the "zabbix" database with the SQL command "SHOW DATABASES;" or directly in the phpMyAdmin GUI at the address "127.0.0.1/phpmyadmin/".





• Importing initial schema and data

For "zabbix" user:

```
zcat /usr/share/doc/zabbix-server-mysql*/create.sql.gz | mysql -
uzabbix -p zabbix
```

For "root" user:

```
zcat /usr/share/doc/zabbix-server-mysql*/create.sql.gz | mysql -
uroot -p zabbix
```

Enter your password.

Check if the import was successful on phpMyAdmin:

← → C ③ 127.0.0.1/phpmy	/admin/	db_structure php?server=18	&db=zabbix&toki	en=f3f717d6f19	a33f82f58b38	f5cd4e2ac					3	2	•
phpMyAdmin	-	Serveur localbost 3306 >	📑 Base de donn	ēes, zabbix									\$ 7
210000	И	Structure 📃 SQL 🤇	Rechercher	Requête	Export	🖬 Import	8	Opérations	n Privil	èges	▼ plus		
vécentes Préférées		Table	Action						Lignes	Туре	Interclassement	Taille	Perte
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information_schema	101	actions	Affic	cher Je Structure	Recherche	r 👫 Insérer 🗑	Vide	r 😄 Supprimer	5	InnoDB	utf8_bin	48 K10	
mysql performance_schema		alerts	👉 📖 Affic	cher 🖌 Structure	Recherche	r 3-i Insérer E	3 Vide	r 🖨 Supprimer		InnoDB	utf8 bin	144	
phpmyadmin		applications		cher Je Structure		- in the second				BOooDB	utf8 bin	64 K10	
temp_database	1											48 K10	
j zabbix	0	application_discovery		cher M Structure		-					utf8_bin		
Tapez pour filtrer cecs. Entriée pour 🗶		application_prototype	會 🔟 Affic	cher Je Structure	Recherche	r 👫 Insérer 🗑	Vide	r 🤤 Supprimer	8 7	InnoDB	utf8_bin	48 Kio	
1 * >>>		application_template	🚖 🔟 Affic	cher 🕅 Structure	Recherche	r 🛃 Insérer 👰	Vide	r 😄 Supprimer	159	InnoDB	utf8_bin	48 K10	1
Nouvelle table		auditlog	Affic	cher Je Structure	Recherche	se Insérer f	Vide	r 😂 Supprimer		InnoDB	utf8_bin	48 K10	
E. 🖌 acknowledges		auditlog_details	🔶 🕅 Affic	cher M Structure	Recherche	r 3-i Insérer B	B Vide	r 😄 Supprimer		InnoDB	utf8_bin	32 K10	
+. Actions		autoreg host		cher 🕞 Structure							utf8 bin	48 K10	
+ alerts						The second second					and the second second	32 K10	
applications application_discovery		conditions		cher M Structure							utf8_bin		
+ application_prototype	0	config	🏫 📋 Affic	cher Jr. Structure	Recherche	r Bå Insérer 🙀	Vide	r 🤤 Supprimer	3	InnoDB	utf8_bin	48 K10	
+ application_template		correlation	습 III Affic	cher 🖟 Structure	Recherche	r 👫 Insérer 🚆	₽ Vide	r 😄 Supprimer	. e	InnoDB	utf8_bin	16 Kio	
auditlog	10	corr_condition	🚖 📋 Affic	cher Je Structure	Recherche	r 🛃 Insérer 🗄	Vide	r 😂 Supprimer	9. e	InnoDB	utf8_bin	32 Ki0	
auditlog_details		corr_condition_group		cher 🕞 Structure	Recherche	r 3-i Insérer 6	3 Vide	r 😄 Supprimer	0	InnoDB	utf8 bin	32 K10	
autoreg_host		corr_condition_tag		cher 🕞 Structure		- China - Chin				InnoDB	utf8 bin	16 K10	
Conditions	14										an a caller a caller	16 K10	
Config	0	corr_condition_tagpair		cher M Structure		-					utf8_bin		
Correlation		corr_condition_tagvalue	會 🗌 Affic	cher 🖟 Structure	Recherche	r ≩é Insérer ⊨	Vide	r 😅 Supprimer		InnoDB	utf8_bin	16 K10	
+ corr_condition_group	0	corr_operation	🊖 🔟 Affic	cher M Structure	Recherche	r 👫 Insérer 🖷	Vide	r 🤤 Supprimer	e	InnoDB	utf8_bin	32 Kio	
+ corr_condition_tag	0	dashboard	🏫 🛄 Affic	cher Je Structure	Recherche	s 🛃 Inserer 🗑	Vide	r 🤤 Supprimer	5 - P	InnoDB	ut/8_bin	32 Ki0	
+ corr_condition_tagpair		dashboard_user	술 III Affic	cher M Structure	Recherche	r 👫 Insérer 🗑	Vide	r 😄 Supprimer		InnoDB	utf8_bin	48 Kio	
+ corr_condition_tagvalue		dashboard_usrgrp		cher Je Structure					. 3	InnoDB	utf8 bin	48 K10	
+ corr_operation												16 K10	
+ dashboard	0	dbversion		cher 🧏 Structure							utf8_bin		
dashboard_user	Ð	dchecks	Affic	cher K Structure	Recherche	se Insérer 🙀	Vide	r 🤤 Supprimer	1	InnoDB	utf8_bin	32 Kio	
dashboard_usrgrp dbversion		dhosts	술 🗐 Affic	cher 🕼 Structure	Recherche	r 🛃 Insérer 👰	Vide	r 🤤 Supprimer	0	InnoDB	utf8_bin	32 K10	
Contraction of the second second	· •	console de requêtes SQL	6 100 B.C.	1	2011	711 5 6	1.166			1 00	+00.11	40.010	



4.2.2. Configuring Zabbix

• Configuring the database

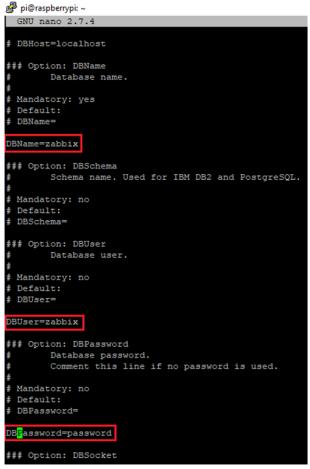
Edit the file "/etc/zabbix/zabbix_server.conf":

```
sudo nano /etc/zabbix/zabbix_server.conf
```

Add the password corresponding to your database at:

```
DBPassword=password
```

Check the database name, user name, port. You can change the cache size so that the server is able to support a larger number of hosts:



```
DBName = zabbix
DBUser=zabbix
```

ListenPort=10051

CacheSize=32

• Configuring PHP

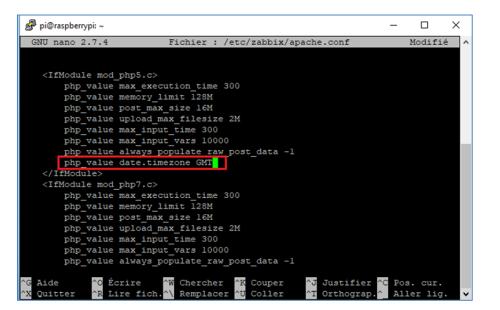
Edit the file "/etc/zabbix/apache.conf":

sudo nano /etc/zabbix/apache.conf

Uncomment the lines below and enter your time zone for versions 5 and 7 of the PHP module (Paris time: UTC+0100):

php_value date.timezone Europe/Paris





• Starting Zabbix

Start Zabbix server and Zabbix agent:

sudo systemctl restart zabbix-server zabbix-agent apache2

Make them start automatically at system startup sudo systemctl enable zabbix-server zabbix-agent apache2

4.2.3. Installing Zabbix front-end

Connect to your Zabbix frontend server at the address "localhost/zabbix/":

C C C C C C C C C C C C C C C C C		ZABBIX	Check of pre-requisites			
				CURRENT VALUE	REQUIRED	ñ
ZABBIX		Welcome Check of pre-regulates	PHP version	5.4.20	5.4.0	OK.
Vertures Chiele of pre-regulation Contrainer Edit Internetiation		Configure D8 connection	PHP option memory_limit	128M	12814	CK.
Zathis server areasy. Wolcome to		Zabbix server details	PHP option post_max_size	32M	16M	OK.
Zabbix 4.0		Pre-installation summary install	PHP option upload_max_filesize	16M	2M	OK
			PHP option max_execution_time	600	300	OK.
			PHP option max_input_time	600	300	OK .
Elimiti 🖉	Nariat Status		PHP time zone	Europe/Riga		OK.
Linemated system (Fig. a)			PHP databases support	MySQL		OK.
			PHP bonath	on		OK.
2000-0-0-0-0700-0700-000-000					Back	Next step

Then, make sure that all software requirements are met.

Enter the connection details to the "zabbix" database:

ZABBIX	Configure DB connection	ZABBIX Zabbix server details
Wecame Check of pre-regulation Condigues OB connection Zabbis server details Pre-installation summary install	Please oreate database menuluy and set the configuration parameters for connection to this database. Press Test test budies to the database point Database point Database point Database name zations Passevoid Passevoid	Please enter the Yout name or Yout IP address and portnumber of the Zabbix server, as well as the name of the instabilition (optional). Check of pre-regulates Host boahost Condigate Discretistion Port 10051 Zabbix server ontails Port 10051 Po
	Back. Need B	Dack Next step

Entering a name for the Zabbix server is optional





Review the summary of the settings and complete the installation.

ZABBIX	Pre-installa	tion summary	ZABBIX	Install
Welcome	Please check config change configuration	aration parameters. If all is correct, press "Next step" button, or "Back" button to n parameters.	Welcome	
theck of pre-requisites	Distabase type	MySQL .	Check of pre-requisites	
Configure DB connection	Dotatione server	localhost	Configure DB connection	
labble server details	Distatiane port	default	Zabbix server detaits	
re-installation summary	Database name	zabbix	Pre-installation pummary	Construction of the second sec
tister	Dubbase user	zabbis	Batare	Congratulations! You have successfully installed Zabbix
	Database password			frontend. Configuration file "Justishaneizabbio/confizabbio/conf.php" created.
	Zabbix server	localhost		
	Zabbix server port	10051		
	Zabbix server harter			
		Back Next step		Back Fin

Zabbix front-end is ready. The default user name is "Admin" and the password is "zabbix".

	ZABBIX	
Username		
Password		
 Remen 	ber me for 30 days	
	Sign in	
	or sign in as guest	

4.2.4. Configuring and managing Zabbix front-end

The connection with the server is operational on port 10051 if you observe "Zabbix server is running" with "Value:Yes".

← → C () localhost/zabbix/zab	bix.php?	action=dashboard	view								a ₀ ⊀	2	• :
ZABBIX Monitoring Invento	ory Re	eports Configura	tion Administr	ation					Q	9 s	upport 🛛 Share	? 📫	Ċ
Dashboard Problems Overview Wel	b Late:	st data Graphs	Screens Maps	Discovery S	Services							zabbix_s	erveur
Global view											Edit dashboar	d 🗏	2
All dashboards / Global view													
System information		***	Problems by	severity						***	Local		
Parameter	Value	Details	Host group 🛦	Disaster	High	Average	Warning	Information	Not classified		1	1	
Zabbix server is running	Yes	localhost10051				No data	found.				-		
Number of hosts (enabled/disabled/templates)	82	1/0/81										-	_
Number of items (enabled/disabled/not supported)	77	70/0/7									× .		-
Number of triggers (enabled/disabled [problem/ok])	46	46/0[0/46]											
Number of users (online)	2	1											
Problems											Favourite maps	5	
Time 👻 Info F	lost	Problem • Seve	ity	C	Duration		Ack	Actions	Tags		No maps a	dded.	
			No dat	a found.									



If you see an error when connecting to Zabbix Front-end (see capture below) check the configuration of the file "/etc/zabbix/zabbix/zabbix_server.conf" or the user rights in MySQL with the SQL command: "SELECT host,user,password,Grant priv,Super priv FROM mysql.user;" by referring to

← → C (© 127.0.0.1/zabbik/queue.php?ddreset=1	Sei 🖈 📕 🦁 :
ZABBIX Monitoring Inventory Reports Configuration Administration	Q Q Support 🛛 Share ? 💄 🙂
General Proxies Authentication User groups Users Media types Scripts Queue	zabbix_serveur
Details Cannot display item queue.	×
Connection to Zabbix server "localhost" refused. Possible reasons: 1. Incorrect server IP/DNS in the "zabbix.conf.php"; 2. Security environment (for example, SELinux) is blocking the connection; 3. Zabbix server daemon not running; 4. Firewall is blocking TCP connection. Connection refused	

Also check that your discovery rules are enabled for your local network in the menu "Configuration > Discovery > Status: Enabled".

ZABBIX Monitoring Inventory Rep	orts Configuration Administration	n		Q O Support Share	? உ 🖱
Host groups Templates Hosts Maintenance	Actions Event correlation Discovery	Services			zabbix_serveur
Discovery rule enabled					×
Discovery rules				Create d	discovery rule
					Filter 7
	Name	Status Any Ena	bled Disabled		
		Apply Reset			
□ Name ▲	IP range	Interval	Checks	Status	
Local network	192.168.0.1-254	1h	Zabbix agent	Enabled	
				Displaying	g 1 of 1 found
0 selected Enable Disable Delete					

Preconfigured items are immediately available in the "Monitoring > Graphs" tab such as the processor load curve of the Raspberry Pi that can be viewed on the right.

the appropriate above sections.





4.3. How to display a temperature in zabbix

We will now configure Zabbix to collect, log and display a temperature.

From a simple command returning a measurement of the DS18B20 "28-*" sensor:

```
sudo /bin/cat /sys/bus/w1/devices/28-0516a4de4cff/w1_slave | awk
'/t=/ {print $10}' | cut -d= -f2 | awk '{sum=$1/1000} END {print
sum}'
```

Go to the folder "etc/zabbix":

```
cd /etc/zabbix/zabbix_agentd.d
```

Create and edit a new file "temp.conf":

sudo nano temp.conf

Add the command to the configuration file that will store the information in Zabbix to display it:

```
UnsafeUserParameters=1
UserParameter=raspi.temp,/bin/cat /sys/bus/w1/devices/28-
0516a4de4cff/w1_slave | awk '/t=/ {print $10}' | cut -d= -f2 | awk
'{sum=$1/1000} END {print sum}'
```

🗬 pi@raspberrypi: /etc/zabbix/zabbix_agentd.d		_		×	
GNU nano 2.7.4	Fichier : temp.conf				^
 <mark>U</mark> nsafeUserParameters=1 UserParameter=raspi.temp,/bin/cat	/sys/bus/wl/devices/28-0516a4de4d	ff/wl	_slave	Ş	

Finally, restart the Zabbix services:

sudo systemctl restart zabbix-server zabbix-agent apache2

Under Zabbix Agent, go to "Configuration > Hosts > Items > Create new item", and enter the name "Name" and the key "Key" in correspondence with the name of the chosen variable of "UserParameter" in the file previously created "temp.conf", namely "raspi.temp".

For the "Host Interface" box, enter the IP address of the host you want to monitor. The agent port is by default "10050" for Zabbix Agent (10051 for Zabbix Server).

You can also configure the data collection interval with "Update interval" and its storage time in the database with "History storage period".



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\sim	BY	84	

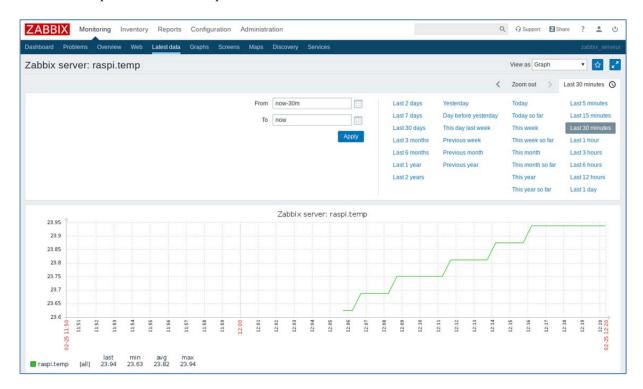
ZABBIX Monitoring	Inventory Reports	Configuration	Administration				Q,	G Support	Z Share	?	<u>.</u>	ڻ ١
Host groups Templates Hosts	Maintenance Actions	Event correlation	on Discovery Services							zabbi	k_serv	eur
Items												
All hosts / Zabbix server Enable	d ZBX SNMP JMX IPMI	Applications 11	Items 87 Triggers 48 Graph	s 14 Disco	very rules 2	Web scenarios						
Item Preprocessing												
* Name	raspi.temp											
Туре	Zabbix agent 🔻											
* Key	raspi.temp			Select								
* Host interface	127.0.0.1 : 10050 🔹											
Type of information	Numeric (float)											
Units												
* Update interval	30s											
Custom intervals	Туре	Interval	Period		Action							
	Flexible Scheduling	50s	1-7,00:00-24:00		Remove							
	Add											
* History storage period	90d											
* Trend storage period	365d											
Show value	As is		•	show value	mappings							
New application												
Applications	None- CPU Filesystems General Memory Network interfaces OS Performance Processes Security											
Populates host inventory field	-None-	٣										
Description	SONDE DS18B20											-

Then go to the menu "Monitoring > Latest data", filter on the name of your object, namely "raspi.temp", you should see a data under "Last value".

	ring Invent	ory Reports	Configu	ration A	dministr	ation					Q	♀ Support	Z Share	?	*	ტ
Dashboard Problems	Overview We	b Latest data	Graphs	Screens	Maps	Discovery	Serv	ices						zab	bix_se	rveur
Latest data																e ⁸
															Filter	7
	Host groups	type here to sea	arch			Sele	ct	Name	pi.temp							
	Hosts	type here to sea	arch			Sele	ct	Show items without data 🔽								
	Application					Sele	ct	Show details								
						A	\pply	Reset								
▼ □ Host		Name 🔺						Last check		Last value		Ch	ange			
 Zabbix server 		- other - (1 lt	em)													
		raspi.temp						2019-02-25	12:12:15	23.81				[Grap	h
0 selected Display stack	ed graph C)isplay graph														



 $\odot \bigcirc \odot$



Click on "Graph" to view the temperature measurements:

4.4. Installing Grafana and Zabbix plugin

4.4.1. Installing Grafana

Get Grafana's sources:

sudo apt-get install apt-transport-https curl
curl https://bintray.com/user/downloadSubjectPublicKey?username=bintray sudo apt-key add -
echo "deb https://dl.bintray.com/fg2it/deb stretch main" sudo tee -a /etc/apt/sources.list.d/grafana.list
sudo apt-get update
sudo apt-get install grafana

For security reasons, the HTTP protocol that allows access to the WEB interface to the Grafana API is disabled. To enable the HTTP protocol, modify the file "/etc/grafana/grafana/grafana.ini":

sudo nano /etc/grafana/grafana.ini



Uncomment the http protocol and port (remove the ";"):

```
[server]
# Protocol (http, https, socket)
protocol = http
# The ip address to bind to, empty will bind to all interfaces
;http_addr =
# The http port to use
http_port = 3000
```

```
pi@raspberrypi: ~
                                                                       ×
GNU nano 2.7.4
                         Fichier : /etc/grafana/grafana.ini
                                                                     Modifié ^
plugins = /var/lib/grafana/plugins
# folder that contains provisioning config files that grafana will apply on sta$
;provisioning = conf/provisioning
[server]
# Protocol (http, https, socket)
protocol = http
# The ip address to bind to, empty will bind to all interfaces
;http addr =
# The http port to use
ttp_port = 3000
# The public facing domain name used to access grafana from a browser
 domain = localhost
             ^O Écrire
^R Lire fich
                                                     Justifier <sup>AC</sup> Pos. cur.
Orthograp.<sup>A</sup> Aller lig
                         <> ∧
                            Chercher
                                         Couper
                                                   ^J
^T
                                         Coller
   Quitter
                            Remplacer
```

Restart Grafana:

sudo service grafana-server restart

Enable the "systemd" service so that Grafana starts when the system starts:

sudo systemctl enable grafana-server.service





4.4.2. Connecting to Grafana

Open your browser and enter the address "http://localhost:3000/login". The default credentials are "admin" / "admin". Note that Grafana has a user management with authentication and rights management.



4.4.3. Installing Grafana-Zabbix plugin

You can get a list of the plugins available for Grafana in your terminal:

grafana-cli plugins list-remote

Install the Zabbix module with grafana-cli:

```
grafana-cli plugins install alexanderzobnin-zabbix-app
```

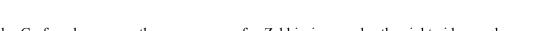
The plugin will be installed in your Grafana plugin directory. The default path is "/var/lib/grafana/plugins".



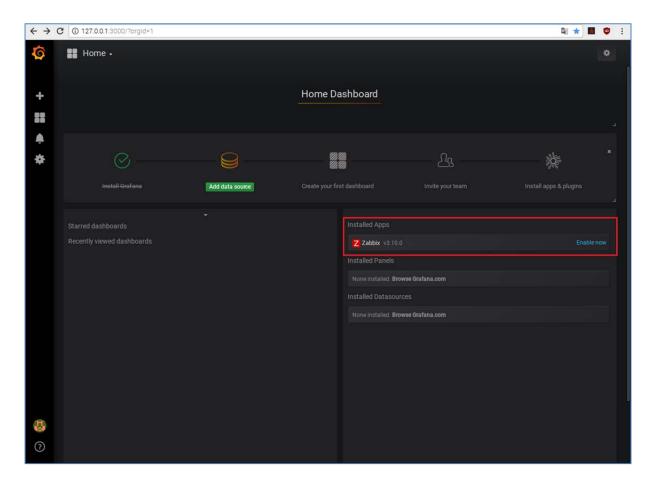
Restart Grafana:

```
service grafana-server restart
```

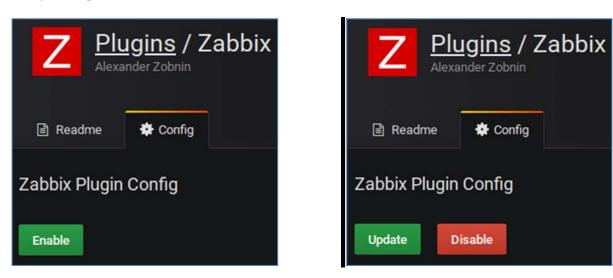




You will see on the Grafana homepage the appearance of a Zabbix icon under the right side panel "Installed Apps".



To activate the Zabbix module click on "Enable Now", then on "Enable". You should see the icons change to "Update" and "Disable".





 (\mathbf{i})

4.5. Displaying a temperature in Grafana

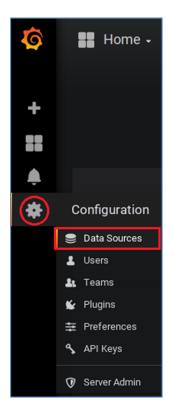
4.5.1. Importing a MySQL source on Grafana

• Configuring the import

We will import these measurements from our SQL "tempLog" into Grafana and create a custom dashboard with two panels, one with raw data, the other graphical.

ture 3QL Rechercher 3H Insferer Export Import Privileges Opfirations > plus ne content pas de colonne unique. Les grilles d'édition, les cases à cocher ainsi que les liens Edition, Copie et Supprimer ne sont pas 25 - 140 (total de 141, Traitement en 0.0028 secondes.) ••• </th
25 - 140 (total de 141, Traitement en 0.0028 secondes.) Profilage [Éditer en ligne] [Modflier] [Expliquer SQL] [Crier code source PHP] [Actual Total afficher Nombre de lignes : 25 • Filtrer les lignes: Chercher dans cette table retare 24 20 24 20 24 20 23 20 23 00
Profilage [Éditer en ligne] [Modifier] [Expliquer SQL] [Otier code source PHP]] Actual Tout atlicher Nombro de lignes : 25 Filtrer les lignes: Chercher dans cette table reture 24.20 24.20 24.30 24.30 25.90 25
Profilage [Éditer en ligne] [Modifier] [Expliquer SQL] [Otier code source PHP]] Actual Tout atlicher Nombro de lignes : 25 Filtrer les lignes: Chercher dans cette table reture 24.20 24.20 24.30 24.30 25.90 25
Profilage [Éditer en ligne] [Modifier] [Expliquer SQL] [Crier code source PHP] [Actual Tout afficher Nombre de lignes : 25 Filtrer les lignes: Chercher dans catte table retaure 24.20 24.20 24.20 24.30 25.30 2
Tout afficher Nombre de lignes: Z5 Fibrer fes lignes: Chercher dans catte table Fibrer fes lignes: Chercher dans
Tout afficher Nombre de lignes: Z5 Fibrer fes lignes: Chercher dans catte table Fibrer fes lignes: Chercher dans
reture 24.20 24.20 24.30 24.30 23.30 23.30
24 20 24 20 24 30 24 30 24 30 23 30
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24.30 24.30 23.90 23.80
24.30 23.90 23.60
23.90 23.80
23.80
23.70
23.60
23.60
23.60
23.60
23.60
23.70
23.80
24.00 24.20
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

To add a new MySQL data source, open "Configuration" in the side panel and click on "Data Sources".





Then, click on "Add data source".

Ô	Conf	figuration					
+							
88	😂 Data Sources	💄 Users	🎎 Teams	🖌 Plugins	🔦 API Keys		
							_
÷	Q Filter by name			: :=		+ Add data source	

Finally, select MySQL in the drop-down list "Type".

() + ::	⊊ Settings	Data Sources / New Type: Graphite			
	Name	name	0	Default	O
*	Туре	Graphite	÷.		
	нттр	CloudWatch Elasticsearch Graphite InfluxDB			
	URL	Microsoft SQL Server MySQL			
	Access	OpenTSDB PostgreSQL Prometheus Zabbix		Help ▶	

Configure the MySQL source named "tempLog" by entering the name of the MySQL database ("temp_database") to import, and the access credentials to this database with User ("root") and Password ("password"). The "Host" port for MySQL is by default "3306".



$\leftarrow \rightarrow$	C 0 127.0.0.1 30	00/datasources/	edit/1								07	■ ☆	۵	:
⊘ + ∷		My SQL	Data Sc Type: MySQL	<u>ources</u> / t	empLog									
 ∻		Name Type	tempLog MySQL		0	Default	g							
		MySQL Con	nection localhost:3306											
		Database User	temp_database	Password										
		are safe so qu	ission user should only be eries can contain ar e Highly recommme	y SQL statement	For example, state	ements like 🚺		sb; and DR	would be e	xecuted. To prote				
		🗸 Databa	ise Connection OK											
5		Save & Test	Delete	Back										

Select "Save & Test". If your configuration is correct, you should see "Database Connection OK".

The source is saved in the "Configuration" menu:

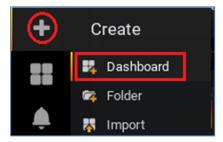
\leftrightarrow \rightarrow	C 127.0.0.1:300	00/datasources	©∎ ☆	 9 :
\$		Configuration Organization: Main Org.		
+		😂 Data Sources 🕹 Users 🎿 Teams 🐇 Plugins 🚔 Preferences 🔦 API Keys		
		Q Filter by name or type		
*				

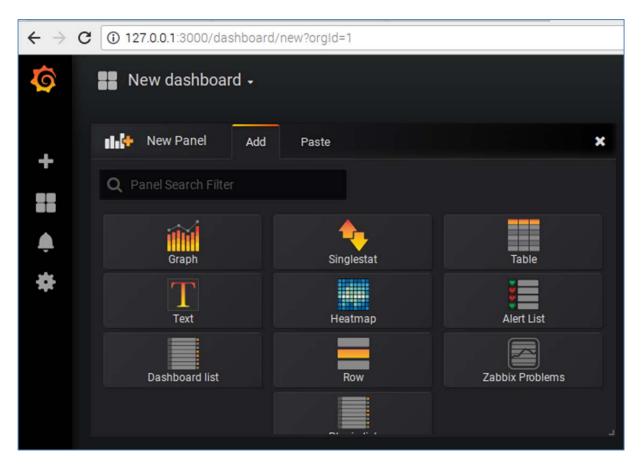
Now that we have configured our MySQL source, we can create a Dashboard, which we will call "Temperature - Server Room (DS18B20)", and which will display our temperatures.



• Creating a "Table" panel

Open the "Create" menu in the side panel and click on "Dashboard" in the drop-down list. To display the raw information collected in the MySQL table "tempLog" and display the values of the columns "datetime" and "temperature", we will create a panel of type "Table" and edit it in our "New dashboard".





Once the "Table" panel has been created, to edit it, select "Edit" from the drop-down menu next to "Panel Title".

The name of the panel can be modified in the "General" tab.





C 127.0.0.1:3000/d/M2ivLsggz/temperature-salle-serveur-ds	s18b20?panelld=4&fullscreen&edit&orgId=1&tab=metrics 🛛 🔯 🐔
Température - salle serveur (DS18B20)	🖆 🖺 🏘 K Q > O Last 6 hours 🕫
	Données brutes 👻
Date +	Température *C
2019-02-26T13:50:02Z	24.00
2019-02-26T13:40:02Z	23.80
2019-02-26T13:30:02Z	23.70
2019-02-26T13:20:03Z	23.60
2019-02-26T13:10:02Z	23.60
2019-02-26T13:00:02Z	23.60
2019-02-26T12:50:02Z	23.60
2019-02-26T12:40:02Z	23.60
2019-02-26T12:30:03Z	23.70
Table General Metrics Options Column S Image: Data Source default •	Styles Time range
A SELECT datetime as 'Date', temperature as 'Température °C' FROM tempLog;	= •
Format as Table - Show Help >	

In the "Metrics" tab, enter the following SQL query:

```
SELECT
   datetime as `Date',
   temperature as `Température °C'
FROM tempLog;
```

If you want to change the name of a column for a more accurate display, it is necessary to enter it in the SQL query (e. g. "temperature as 'Temperature $^{\circ}C'$ ").



• Creating a "Graph" panel

To display information graphically, you can create a "Graph" panel and edit it.



In the "Metrics" tab, enter the following SQL query:

```
SELECT
 UNIX_TIMESTAMP(datetime) as time_sec,
 temperature as value,
 'temperature' as metric
 FROM tempLog
WHERE $___timeFilter(datetime)
ORDER BY datetime ASC;
```

To change the y-axis unit and display a legend in °Celsius, choose from the Axes tab: "Axes > Left Y > Unit > temperature > Celsius (°C)".





Both panels are now visible on our dashboard:

Q,	Température - salle serve	ur (DS18B20) -	🇤 ☆ 🖒 🖺 🍁 < Q > 📀 Last 6 hours 🤤
	MySQL - D	onnées brutes (10 minutes)	MySQL - Graphique (10 minutes)
ŧ.	Date -	Température *C	29 °C
	2019-02-26T16:30:03Z	28.10	28 °C
10	2019-02-26T16:20:02Z	28.10	
Ì.	2019-02-26T16:10:03Z	27.80	27 °C
¥	2019-02-26T16:00:03Z	27.70	26 °C
	2019-02-26T15:50:02Z	27.60	25 °C
	2019-02-26T15:40:03Z	27.30	
	2019-02-26T15:30:02Z	27.80	24 'C
	2019-02-26T15:20:02Z	27.80	23 °C
	2010_02_26T15-10-027	27 R0 1 2	11:00 12:00 13:00 14:00 15:00 16:00 — Température °C

4.5.2. Importing a Zabbix source on Grafana

• Configuring the import

After activating the plugin, you can add the Zabbix data source. To add a new MySQL data source, open "Configuration" in the side panel and click on "Data Sources". Then click on "Add data source". Finally, select "MySQL" from the "Type" drop-down list.

The important fields to be filled in are:

- Name: The name of the server. Here named after our Zabbix server "zabbix server";
- Host: Fill in the URL of the full path to Zabbix with "api_jsonrpc.php". Here: "http://localhost/zabbix/api_jsonrpc.php";
- Access: Left by default in "Server (Default)";
- Userame and Password: You must enter your Zabbix login details (the default login details are "Admin" / "zabbix").

For more information on configuring a Zabbix source in Grafana, please consult the appropriate documentation: <u>http://docs.grafana-zabbix.org/installation/configuration/</u>.



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The source is saved in the "Configuration" menu:

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• Creating a Dashboard with a Zabbix source

On your dashboard, create a new Graph panel. Then in the Metrics tab, fill in:

- Data source: Zabbix (here by default)
- Group: Zabbix servers
- Host: Zabbix server
- Item: "raspi.temp" identical to the name of the object or item we had previously created on Zabbix front-end (see capture below), to perform a temperature measurement every 30 seconds.

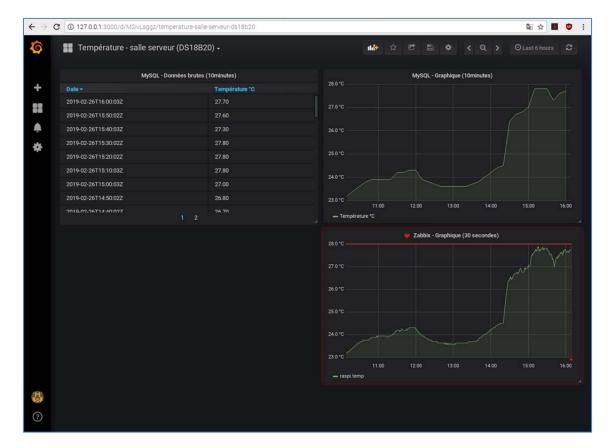
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You should see data from your Zabbix source appear:

It is possible to display on the same dashboard, panels with different sources (here MySQL and Zabbix).





5. Sources

These sources were consulted on February 4, 2019:

- Code4Pi Les bases : <u>https://code4pi.fr/category/bases/</u>
- Projets DIY Tutoriels Raspbian : <u>https://projetsdiy.fr/category/mini-pc-ordinateur-carte/raspberry-pi/tutoriels-raspbian-raspberrypi-francais/</u>
- Blog Framboise314 : <u>https://www.framboise314.fr/</u>

These sources were consulted on February 12, 2019:

- Adafruit's Raspberry Pi Lesson 11. DS18B20 Temperature Sensing : <u>https://learn.adafruit.com/adafruits-raspberry-pi-lesson-11-ds18b20-temperature-sensing/software/</u>
- Raspberry Pi Temperature Sensor Web Server : <u>https://wingoodharry.wordpress.com/2014/12/24/raspberry-pi-temperature-sensor-web-server-part-1-intro-sensor-setup-and-python-script/</u>
- Installer un serveur web sur votre Raspberry (Apache + PHP + MySQL) : <u>https://raspbian-france.fr/installer-serveur-web-raspberry-lamp/</u>
- PDO :: __construct : <u>http://php.net/manual/fr/pdo.construct.php</u>/

These sources were consulted on February 20, 2019:

- Download and install Zabbix : <u>https://www.zabbix.com/download?zabbix=4.0&os_distribution=raspbian&os_version=9_stre_tch&db=mysql/</u>
- Installing Frontend : <u>https://www.zabbix.com/documentation/4.0/manual/installation/install#installing_frontend/</u>
- Zabbix Documentation 4.0 : <u>https://www.zabbix.com/documentation/4.0/manual/</u>
 Stackoverflow « cannot grant privileges to mysql database » :
- https://stackoverflow.com/questions/19237475/cannot-grant-privileges-to-mysql-database/
- Raspberry PI Temperature monitoring with Zabbix : <u>https://sysadmin-</u> ramblings.blogspot.com/2017/04/raspberry-pi-temperature-monitoring.html/
- SQL Data Source Configuration : <u>http://docs.grafana-zabbix.org/installation/configuration-sql/</u>
- Installer Grafana sur Raspbian pour Raspberry Pi : <u>https://projetsdiy.fr/grafana-graphiques-installation-macos-mysensors-influxdb-partie1/</u>
- Using MySQL in Grafana : <u>http://docs.grafana.org/features/datasources/mysql/</u>

