PHARO IOT

Using Pharo to playing with GPIOs and sensors on IoT devices remotely

HELLO!

Marcus Denker
CR1 Inria (tenured researcher)
marcus.denker@inria.fr

Allex Oliveira
IoT Engineer
allex.oliveira@msn.com

SUMMARY

1 - OVERVIEW

- Created by **Rmod Team**, a research team from **INRIA** (France)
- Written by Denis Kudriashov in 2016/17

  dionisiydk@gmail.com
- In 2018, Allex Oliveira joined the Rmod Team to continue the project

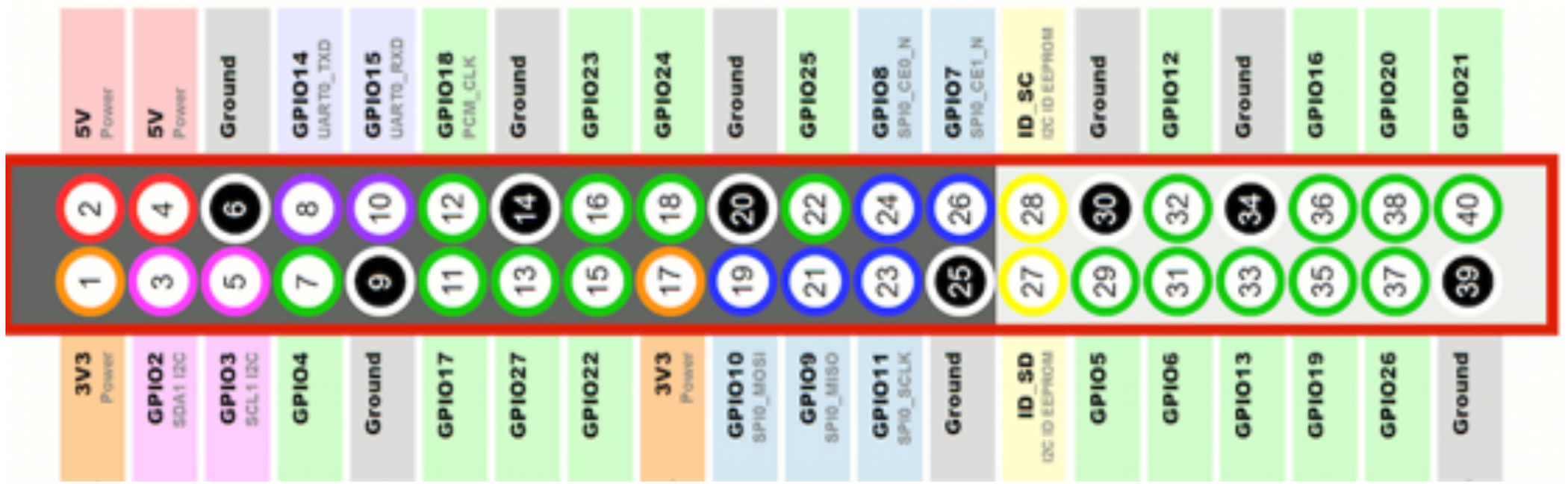
1 - OVERVIEW

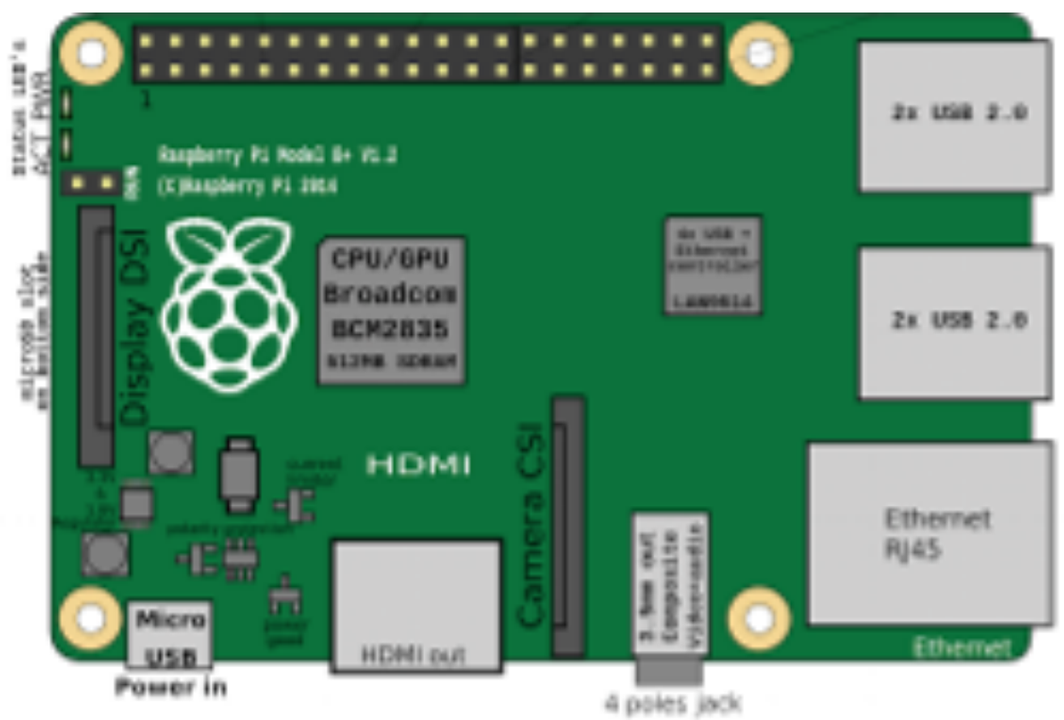
What is PharoThings?

- A Pharo image running on IoT device (ARM VM)
- A Pharo image controlling remote IoT device

- A Pharo library running on Raspberry Pi to control GPIOs through an object board model (using Wiring Pi)
- A Pharo library to control Arduino Devices (using Firmata)
- An advanced board model inspector
- Remote IDE (TelePharo)

1 - OVERVIEW


5V Power
5V Power
Ground
GPIO14 UART0_TXD
GPIO15 UART0_RXD
GPIO18 PCM_CLK
Ground
GPIO23
GPIO24
Ground
GPIO25
GPIO8 SPI0_CE0_N
GPIO7 SPI0_CE1_N
ID_SC I2C ID EEPROM
Ground
GPIO12
Ground
GPIO16
GPIO20
GPIO21
3V3 Power
GPIO2 SDA1 I2C
GPIO3 SCL1 I2C
GPIO4
Ground
GPIO17
GPIO27
GPIO22
3V3 Power
GPIO10 SPI0_MOSI
GPIO9 SPI0_MISO
GPIO11 SPI0_SCLK
Ground
ID_SD I2C ID EEPROM
GPIO5
GPIO6
GPIO13
GPIO19
GPIO26
Ground

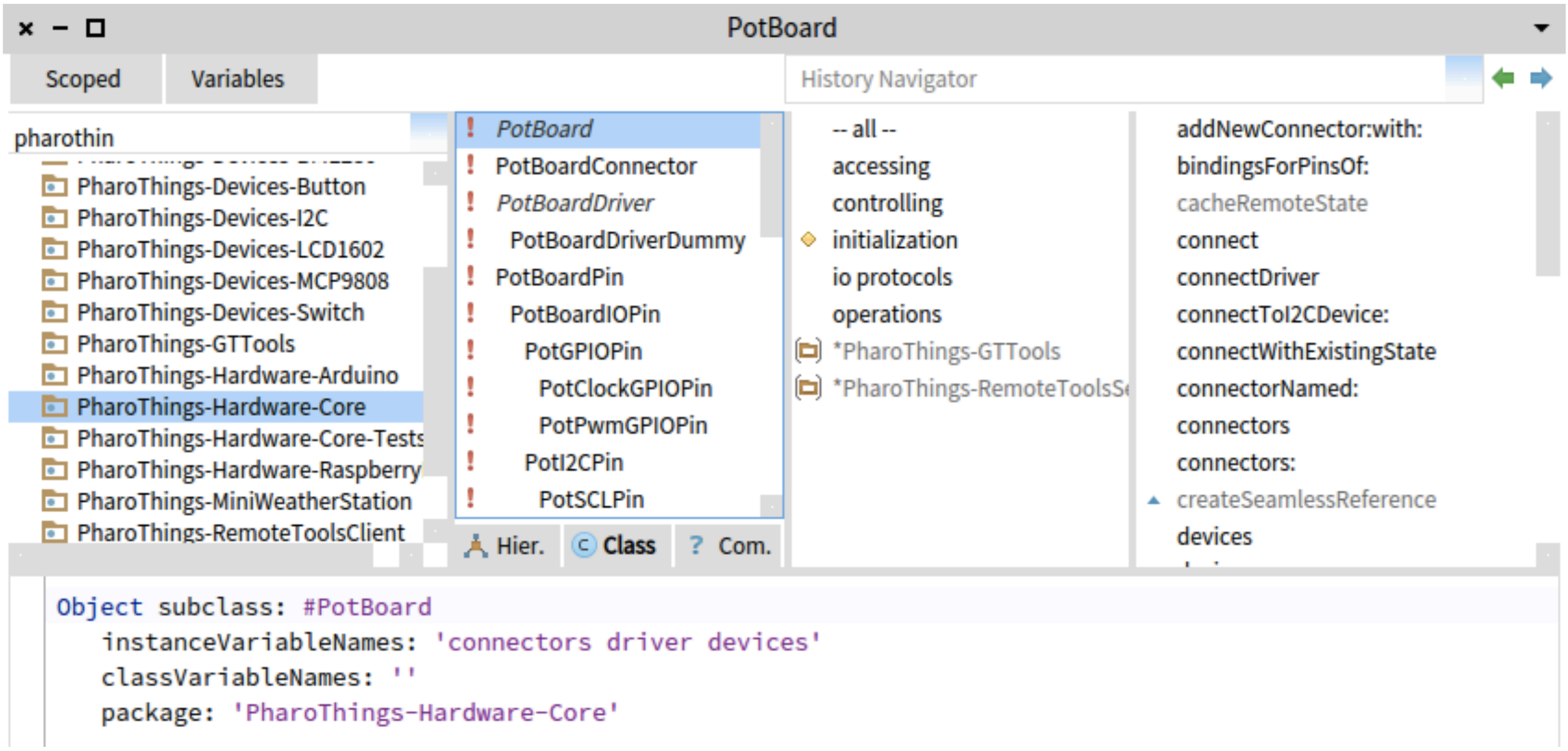

Raspberry Pi Model B+ V1.2
CPU/GPU
Broadcom
BCM2835
Display DSI
HDMI
Camera CSI
2x USB 2.0
2x USB 2.0
Ethernet
RJ45
Micro
USB
Power in
HDMI out
4 poles jack
Ethernet

1 - OVERVIEW

- GPIO pins (general-purpose input/output), I2C, SPI
- Board modelling library which simplifies board configuration
- Raspberry Pi only (for now)

1 - OVERVIEW

PharoThings Library

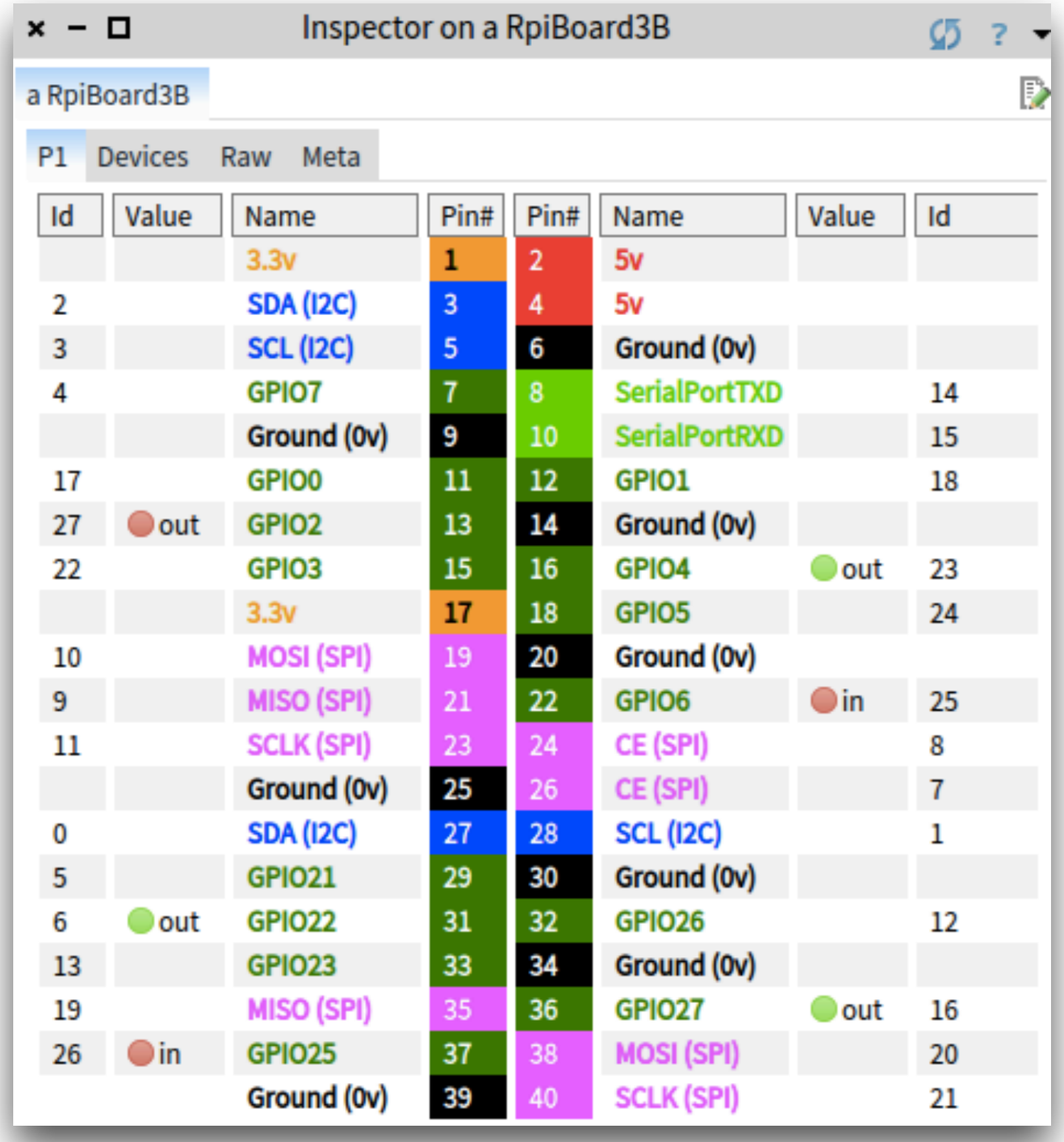



```
Object subclass: #PotBoard
   instanceVariableNames: 'connectors driver devices'
   classVariableNames: ''
   package: 'PharoThings-Hardware-Core'
```

1 - OVERVIEW

Board Inspector

- Provides a scheme of pins similar to physical position
- A live tool which represents the current pins state
- Digital pins are shown with green/red icons which represent high/low (1/0) values



Id	Value	Name	Pin#	Pin#	Name	Value	Id
		3.3v	1	2	5v		
2		SDA (I2C)	3	4	5v		
3		SCL (I2C)	5	6	Ground (0v)		
4		GPIO7	7	8	SerialPortTXD		14
		Ground (0v)	9	10	SerialPortRXD		15
17		GPIO0	11	12	GPIO1		18
27	out	GPIO2	13	14	Ground (0v)		
22		GPIO3	15	16	GPIO4	out	23
		3.3v	17	18	GPIO5		24
10		MOSI (SPI)	19	20	Ground (0v)		
9		MISO (SPI)	21	22	GPIO6	in	25
11		SCLK (SPI)	23	24	CE (SPI)		8
		Ground (0v)	25	26	CE (SPI)		7
0		SDA (I2C)	27	28	SCL (I2C)		1
5		GPIO21	29	30	Ground (0v)		
6	out	GPIO22	31	32	GPIO26		12
13		GPIO23	33	34	Ground (0v)		
19		MISO (SPI)	35	36	GPIO27	out	16
26	in	GPIO25	37	38	MOSI (SPI)		20
		Ground (0v)	39	40	SCLK (SPI)		21

1 - OVERVIEW

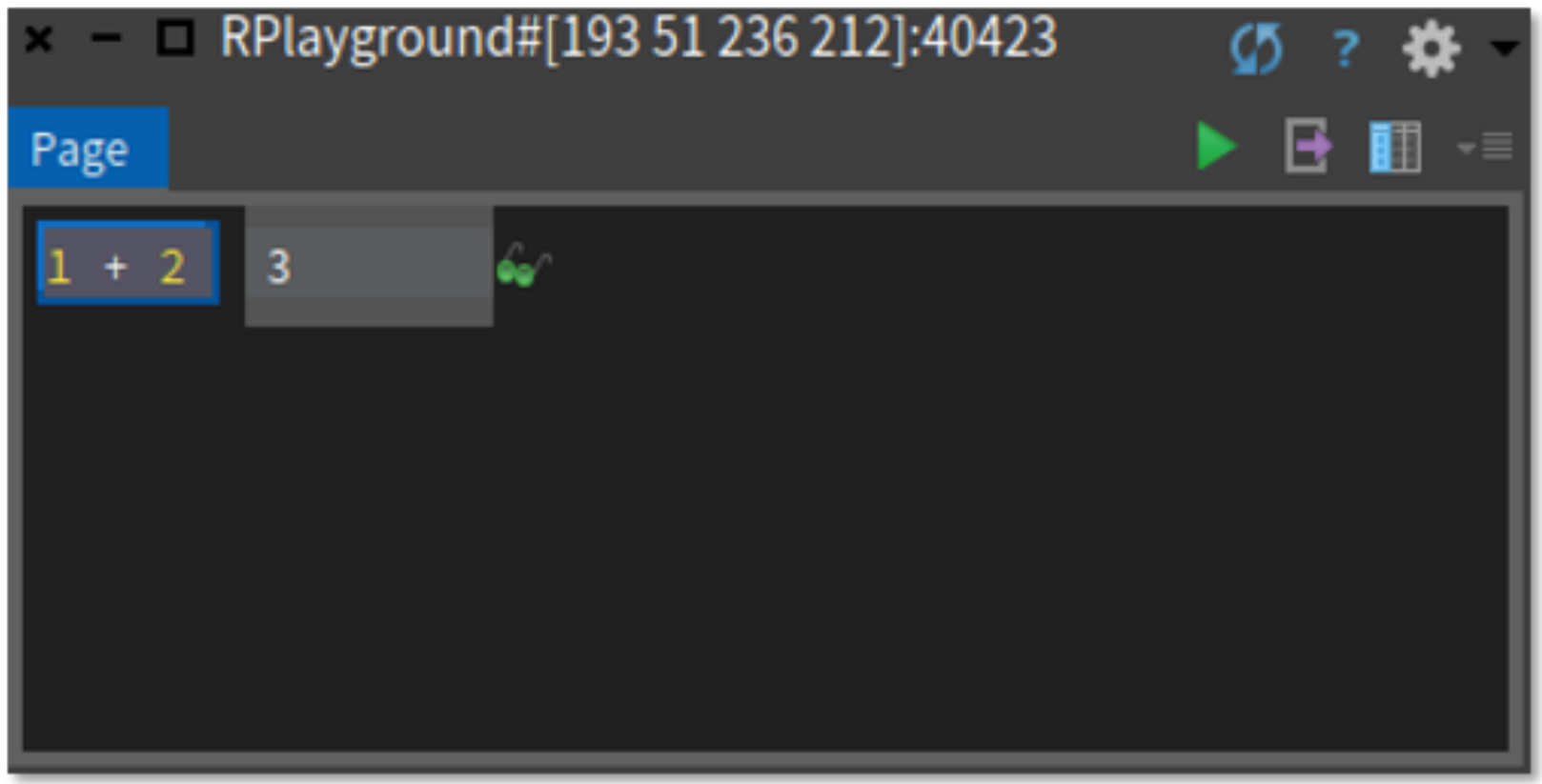
*With PharoThings you can to develop tools to lively program, explore and debug **remote** boards.*

- It is part of **TelePharo** project
- With remotePharo instance you can open:
  - **remote playground**
  - **remote system browser** or
  - **remote process browser**

```
remotePharo := TlpRemoteIDE connectTo: (TCPAddress ip: #[193 51 236 212] port: 40423).
remotePharo openPlayground.
remotePharo openBrowser.
remotePharo openProcessBrowser.
TlpRemoteIDE disconnectAll.
```

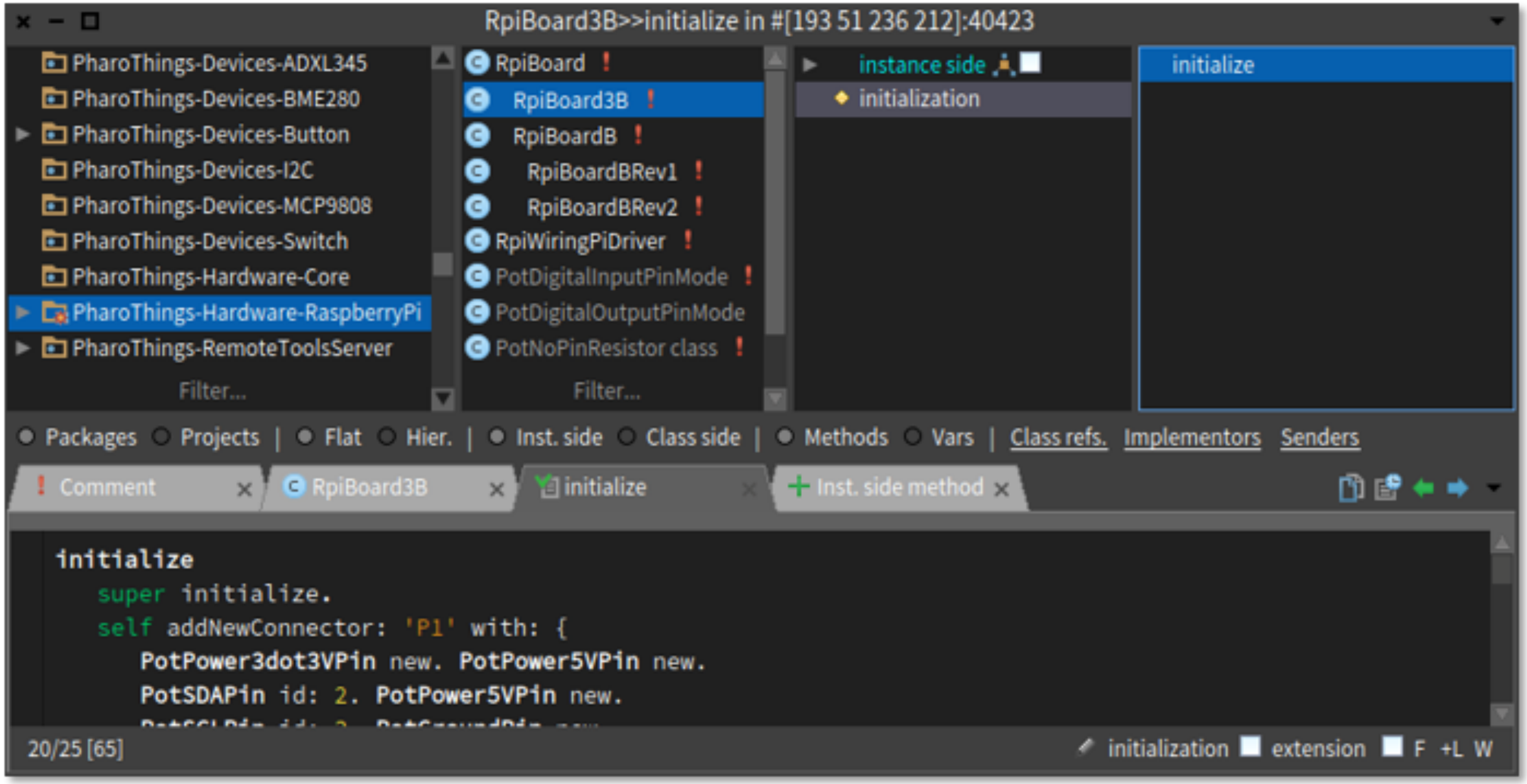
1 - OVERVIEW

Remote Playground



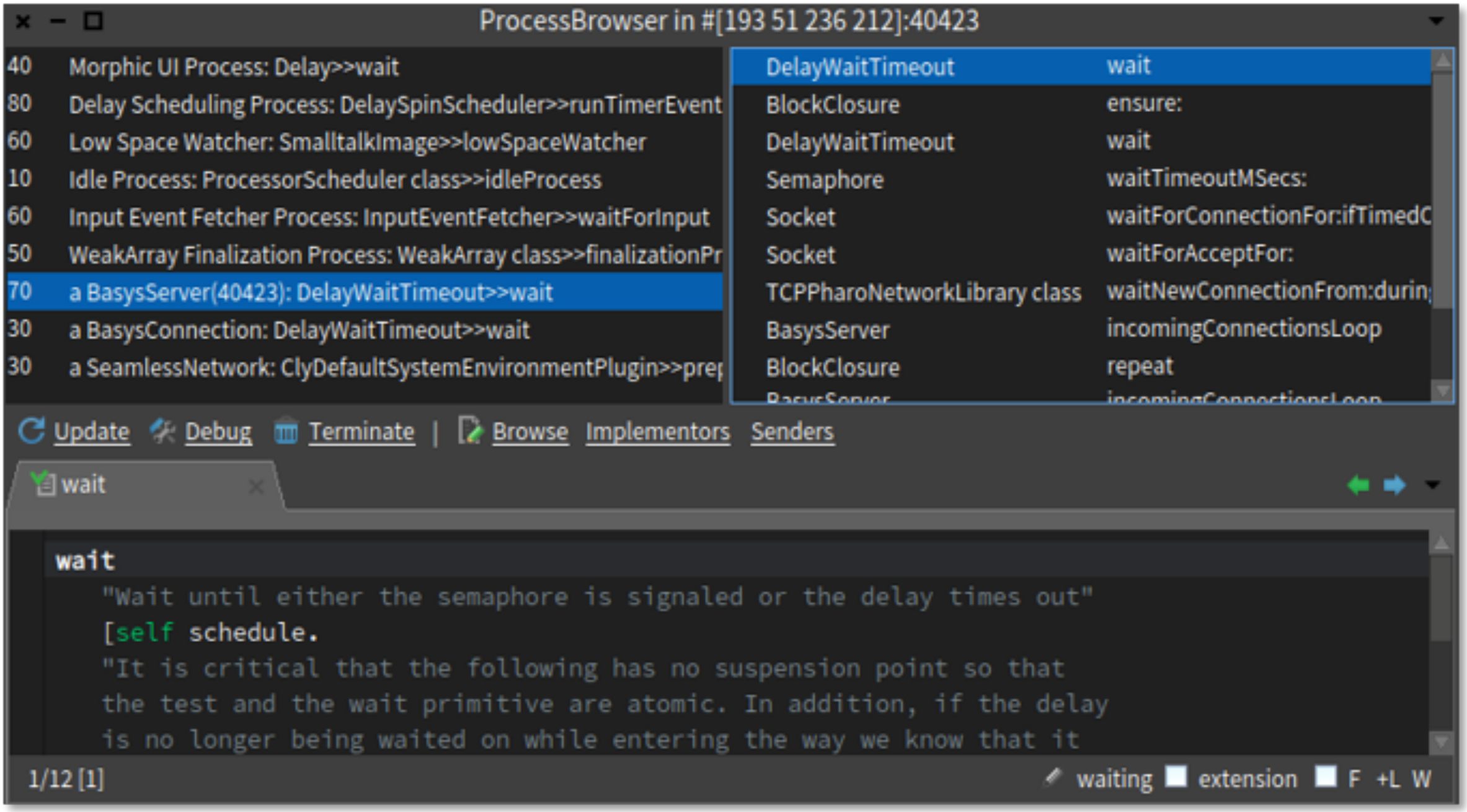
1 - OVERVIEW

Remote System Browser



1 - OVERVIEW

Remote Process Browser



2 - INSTALLATION

How to run Pharo on ARM architecture?

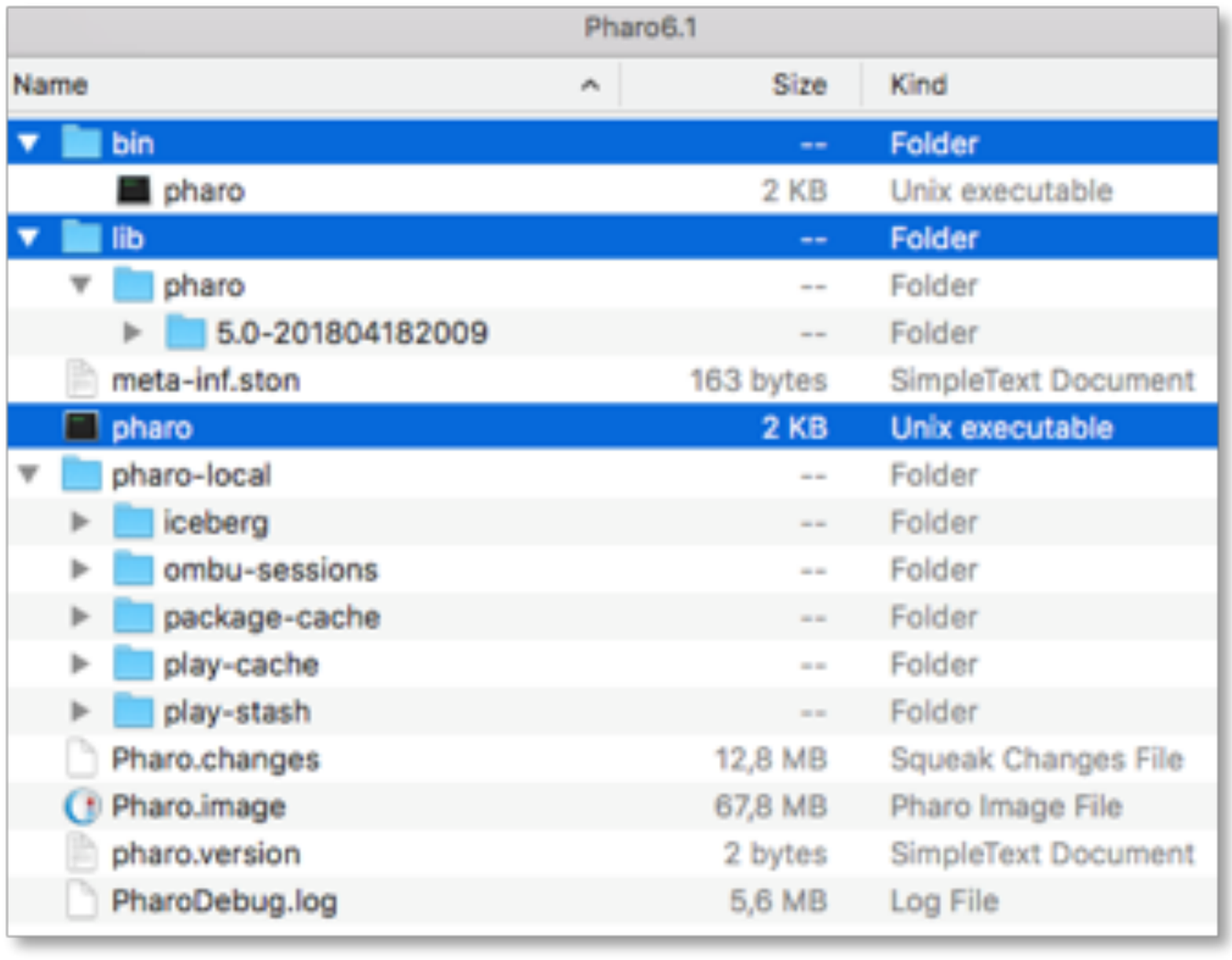
- Metacello new
  baseline: 'PharoThings';
  repository: 'github://pharo-iot/PharoThings/src';
  load: #(RemoteDevServer Raspberry).

- Metacello new
  baseline: 'PharoThings';
  repository: 'github://pharo-iot/PharoThings/src';
  load: 'RemoteDev'

2 - INSTALLATION

- ArmVM:

files.pharo.org/vm/pharo-spur32/linux/armv6/latest.zip

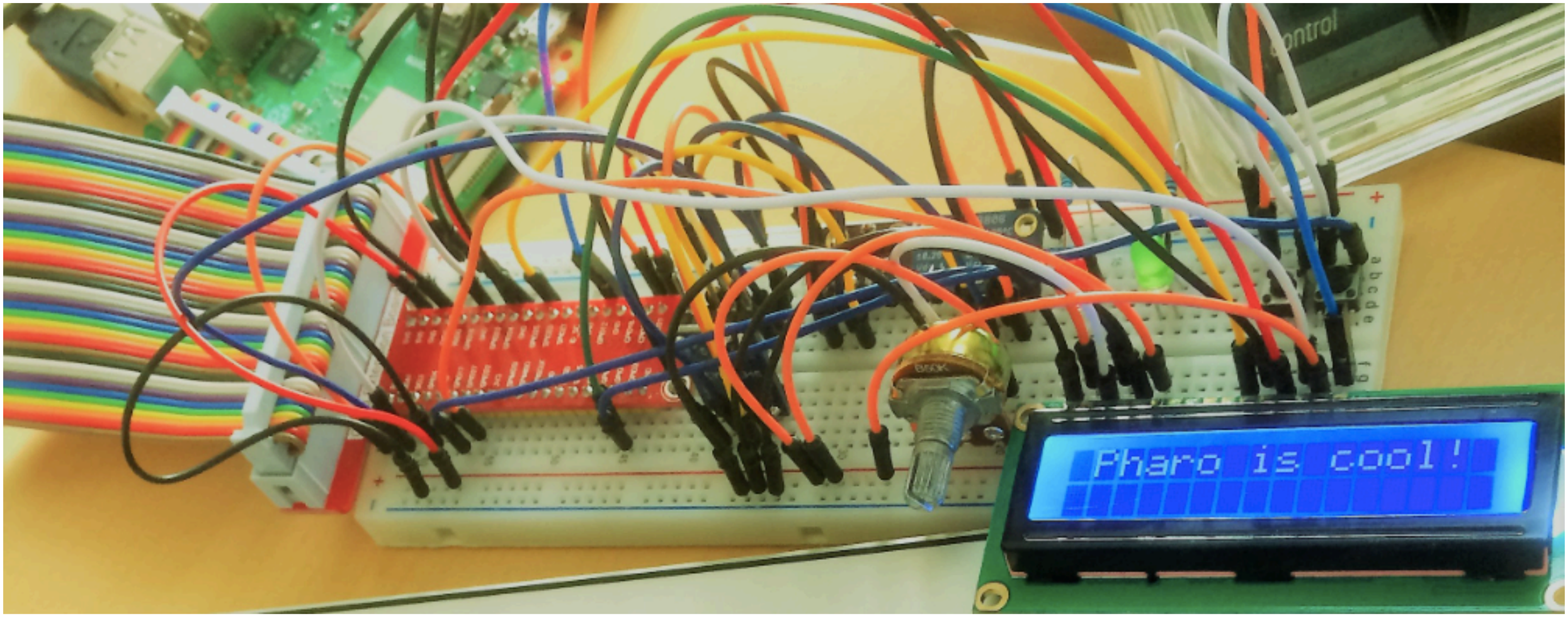


2 - INSTALLATION

- #chmod +x pharo
- #chmod +x lib/pharo/5.0-20180418200 9/pharo
- #./pharo Pharo.image
- #./pharo --headless Pharo.image remotePharo --startServerOnPort=40423

3 - PLAYING

Controlling LEDs, sensors and LCD display remotely



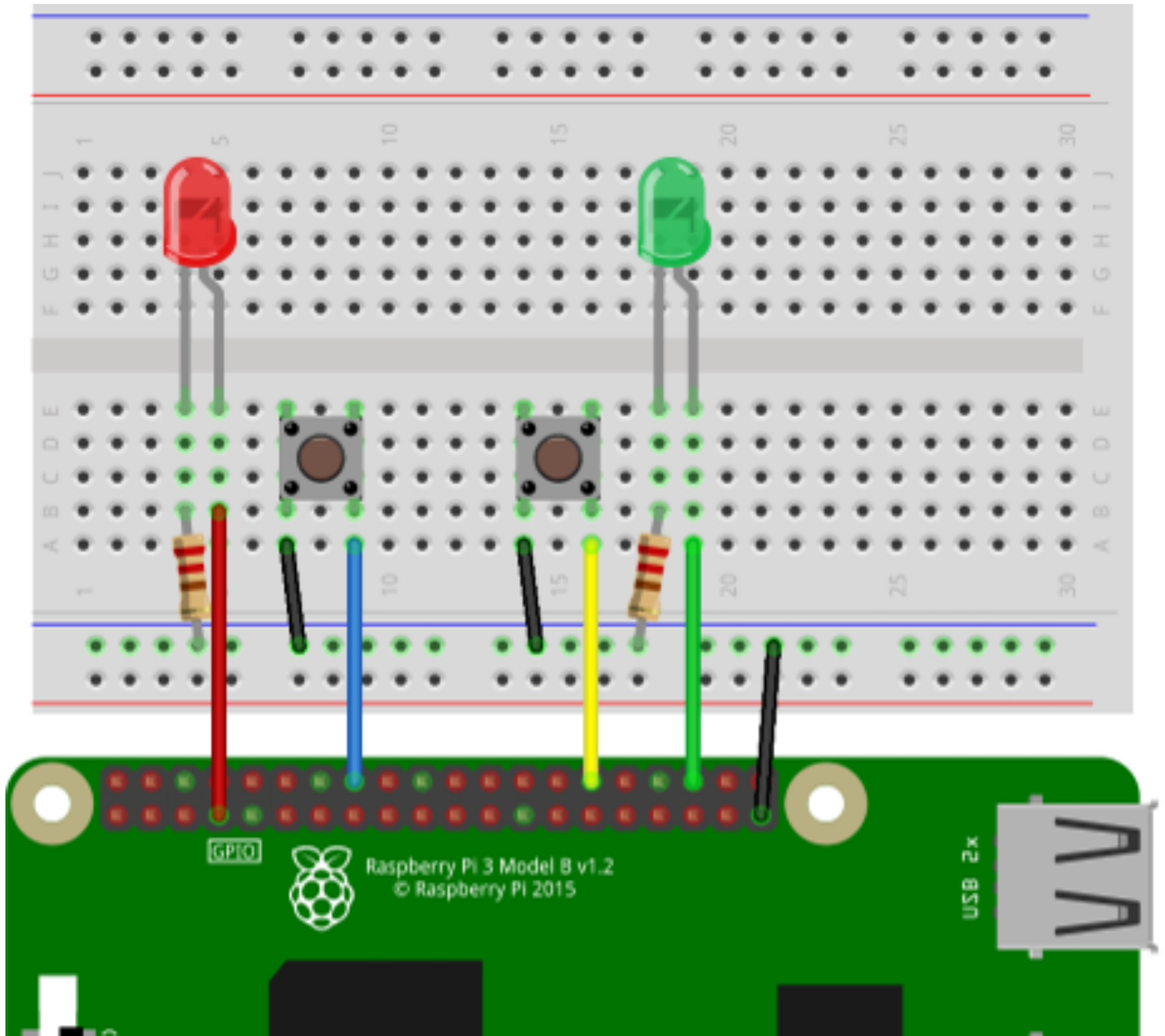
3 - PLAYING

Playing with LEDs and Button

- 1 Raspberry Pi (any model) connected to your network (wired or wireless)
- 1 Breadboard
- 2 LEDs
- 2 Buttons
- 2 Resistors (330ohms)
- Jumper wires

3 - PLAYING

Playing with LEDs and Button



3 - PLAYING

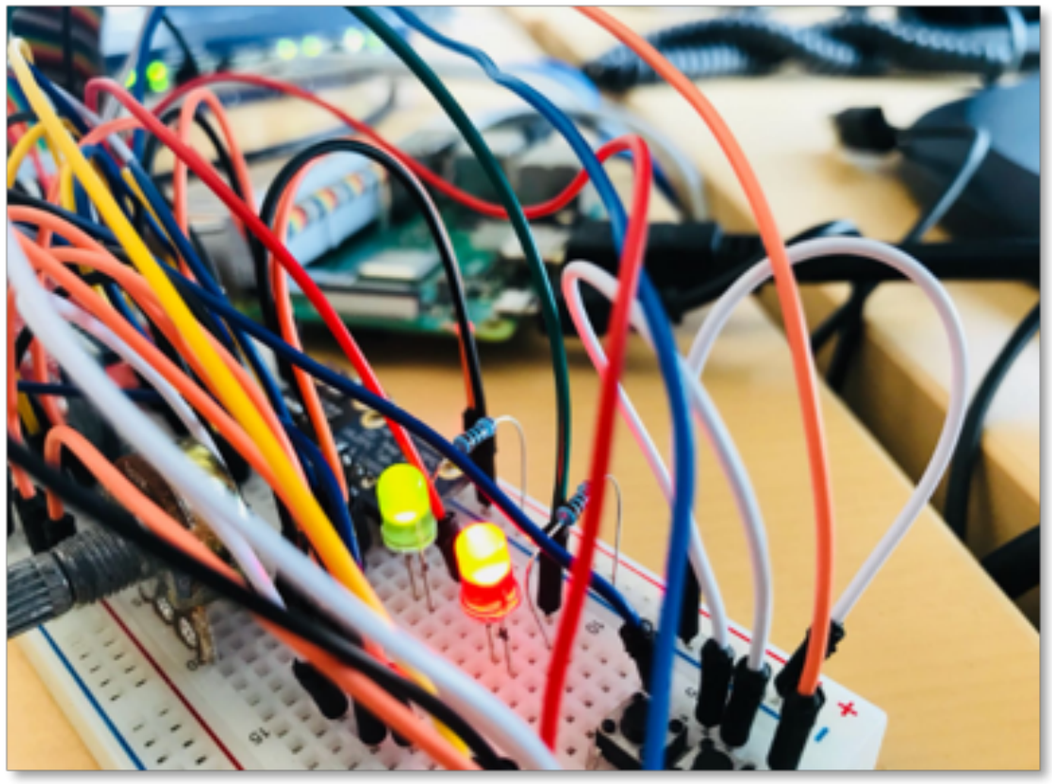
Playing with LEDs and Button

```
ledRed := gpio22.
ledRed beDigitalOutput.
ledRed value: 1.
ledRed toggleDigitalValue.

buttonRed := gpio25.
buttonRed beDigitalInput.
buttonRed enablePullUpResister.

buttonProcess := [ [100 milliSeconds wait.
    ledRed value: (buttonRed value=0) asBit
    ] repeat
    ] forkNamed: 'button process'.

buttonProcess terminate.
```



3 - PLAYING

Playing with Sensors (I2C)

1 Raspberry Pi (any model) connected to your netw ork (wired or wireless)

- 1 Breadboard
- 1 BME280 sensor (Temperature, pressure and humidity)
- 1 MCP9808 sensor (Temperature)
- 1 ADXL345 sensor (Acelerometer, axis X, Y and Z)
- Jumper wires

3 - PLAYING

Playing with Sensors (I2C)

3 - PLAYING

Playing with Sensors (I2C)

- Add the follow line in /boot/config.txt
  dtparam=i2c1=on
- Add the ‘pi’ user to I2C group and restart the Raspberry
  sudo adduser pi i2c
- Code:

```
a:= board installDevice: PotBME280Device new.
    a readParameters.
b := board installDevice: PotMCP9808Device new.
    b readTemperature.
c := board installDevice: PotADXL345Device new.
    c readCoordinates.
```

3 - PLAYING

Playing with Sensors (I2C)

```
a := board installDevice: PotBME280Device new.

a readParameters.   #(26.867964648851192 1011.8081171444288 38.00360479983378)
```

```
b := board installDevice: PotMCP9808Device new.

b readTemperature.   26.625
```

```
c := board installDevice: PotADXL345Device new.

c readCoordinates.   #(2 65269 21)
```

3 - PLAYING

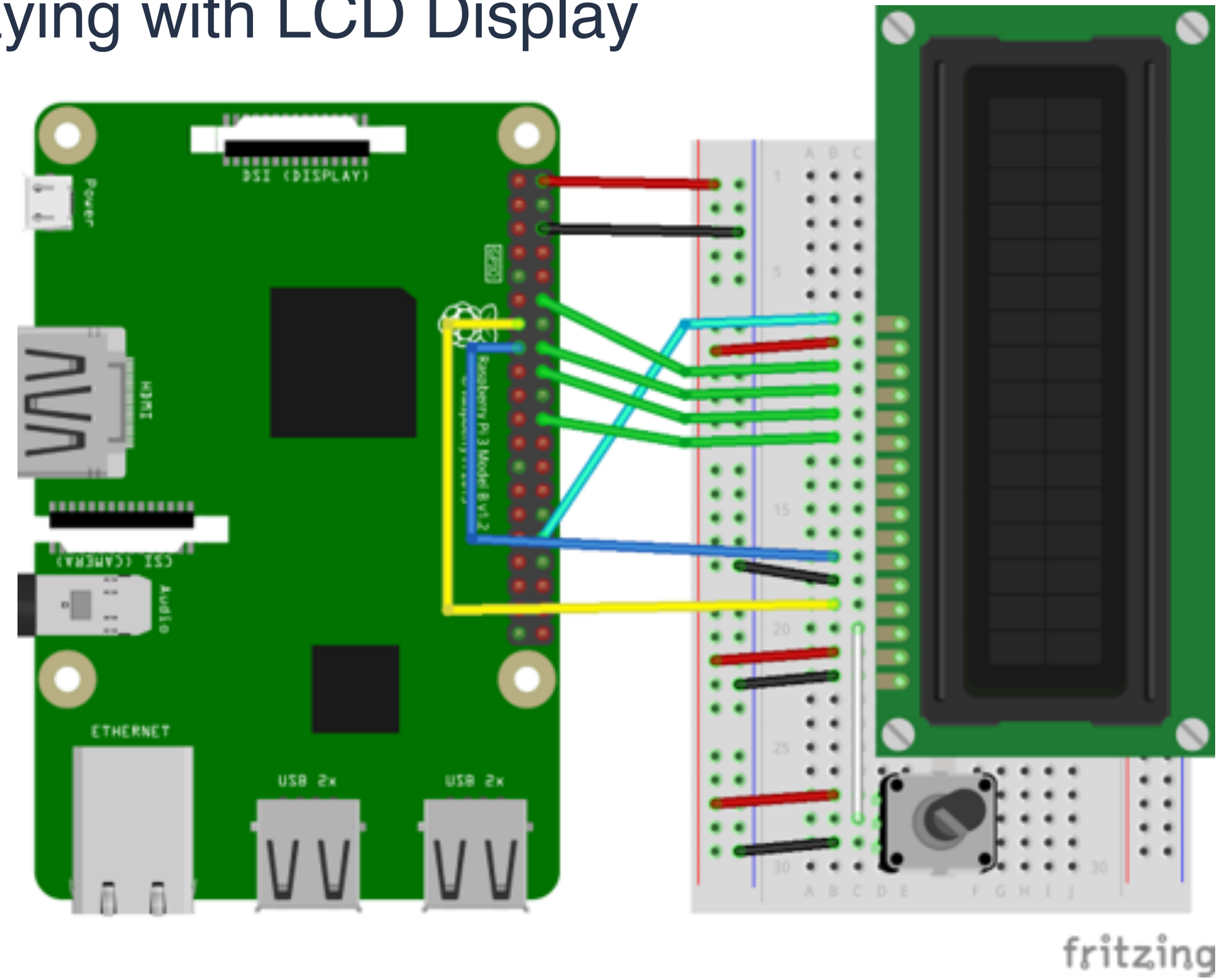
Playing with LCD Display

1 Raspberry Pi (any model) connected to your netw ork (wired or wireless)

- 1 Breadboard
- 1 LCD 1602
- Jumper wires

3 - PLAYING

Playing with LCD Display



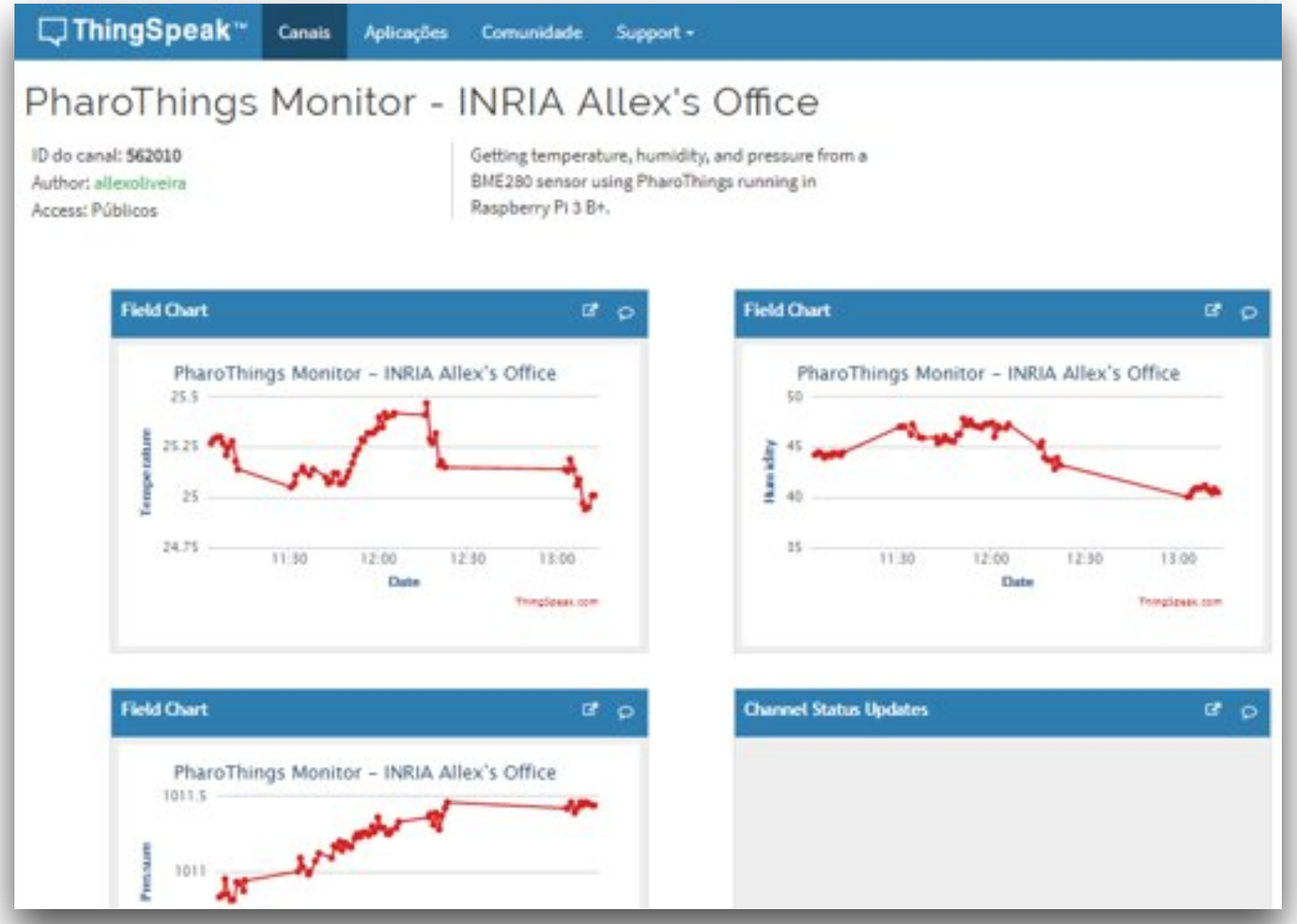
3 - PLAYING

Playing with LCD Display

```
lcd := board installDevice: PotLCD1602Device new.
lcd message: 'Hello everybody!\Pharo is cool!'.
lcd clear.
```

4 - PERSONAL WEATHER STATION

Taking the sensor data with Pharo, showing in LCD display and sending to a remote server



4 - PERSONAL WEATHER STATION

- We will run PharoThings in a Raspberry Pi

- To collect the sensor data (BME280)
  temperature, humidity and pressure

- Show this data in a LCD

- Send the data to a remote server

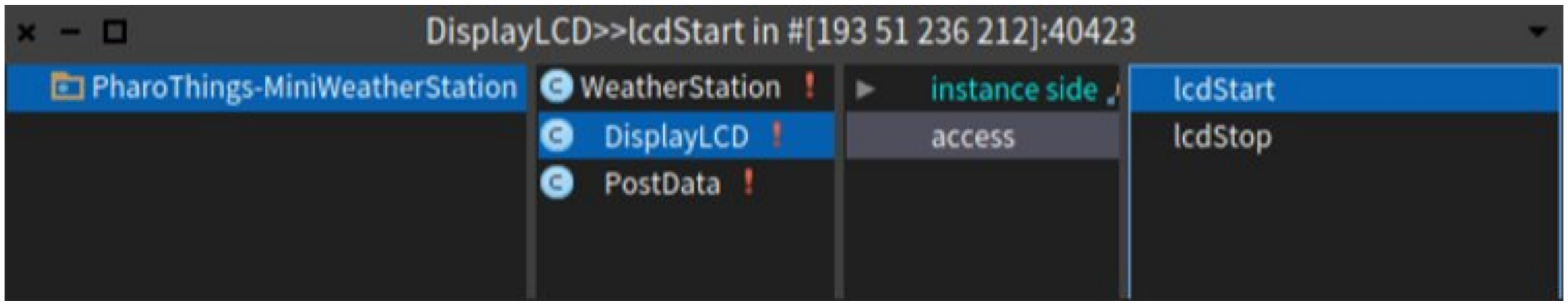
4 - PERSONAL WEATHER STATION

- Created class to instantiate the LCD and Sensor

- Created subclass to create process:

  print information on LCD each 1 second

  send data to a webserver in cloud each 1 minute



4 - PERSONAL WEATHER STATION

- Started Pharo on Raspberry boot with arguments to start the 2 process (DisplayLCD and PostData)

/etc/init.d/pharo.sh

```
#PATH=/home/pi/pharo-iot/
#NAME=pharo
sudo /home/pi/pharo-iot/pharo --headless /home/pi/pharo-iot/Pharo6.1-IoT.image /home/pi/pharo-iot/start.st
exit
```

/home/pi/pharo-iot/start.st

```
(DisplayLCD new) lcdStart.
(PostData new) apiKey:'F1MKEG7PJ4JY30L8'; dataStart.
TlpRemoteUIManager registerOnPort: 40423.
```

LCD Display

5 - THE FUTURE

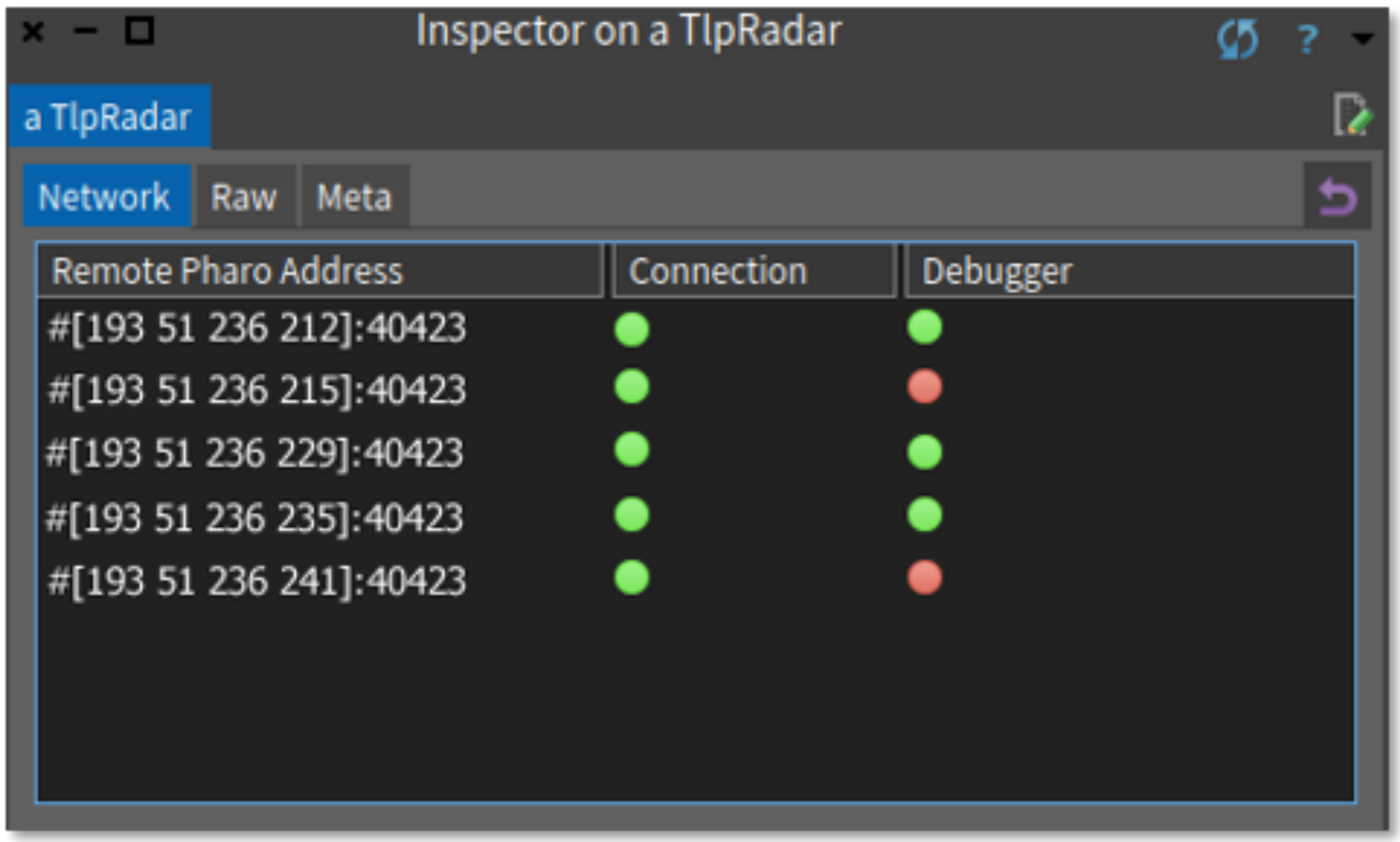
Projects and news

- Beaglebone models
- Zeroconf for armVM + PharoThings
- Remote refactoring
- Security

5 - THE FUTURE

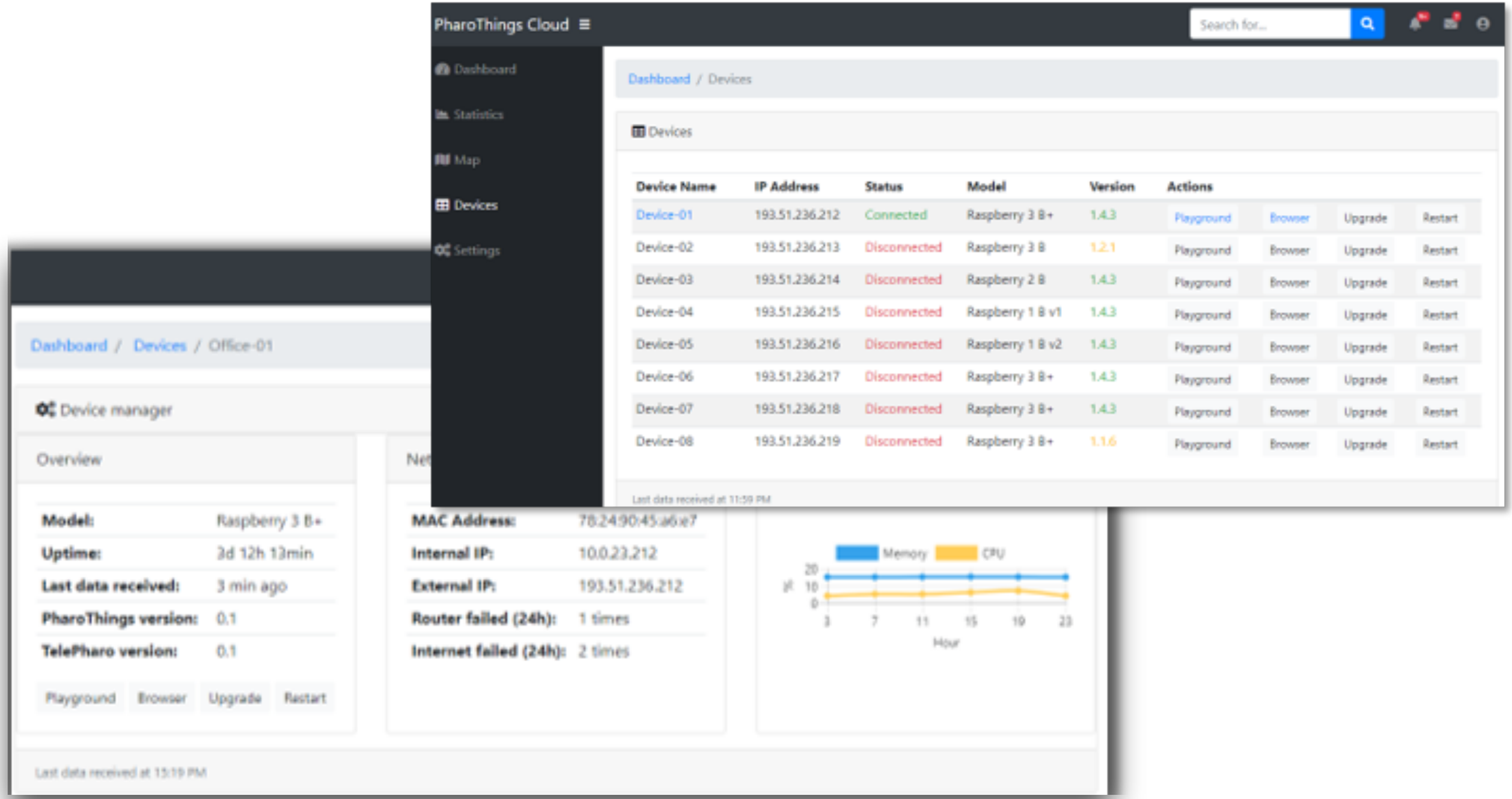
Automatic detection of running images in network

(TeleRadar using SSDP protocol)



5 - THE FUTURE

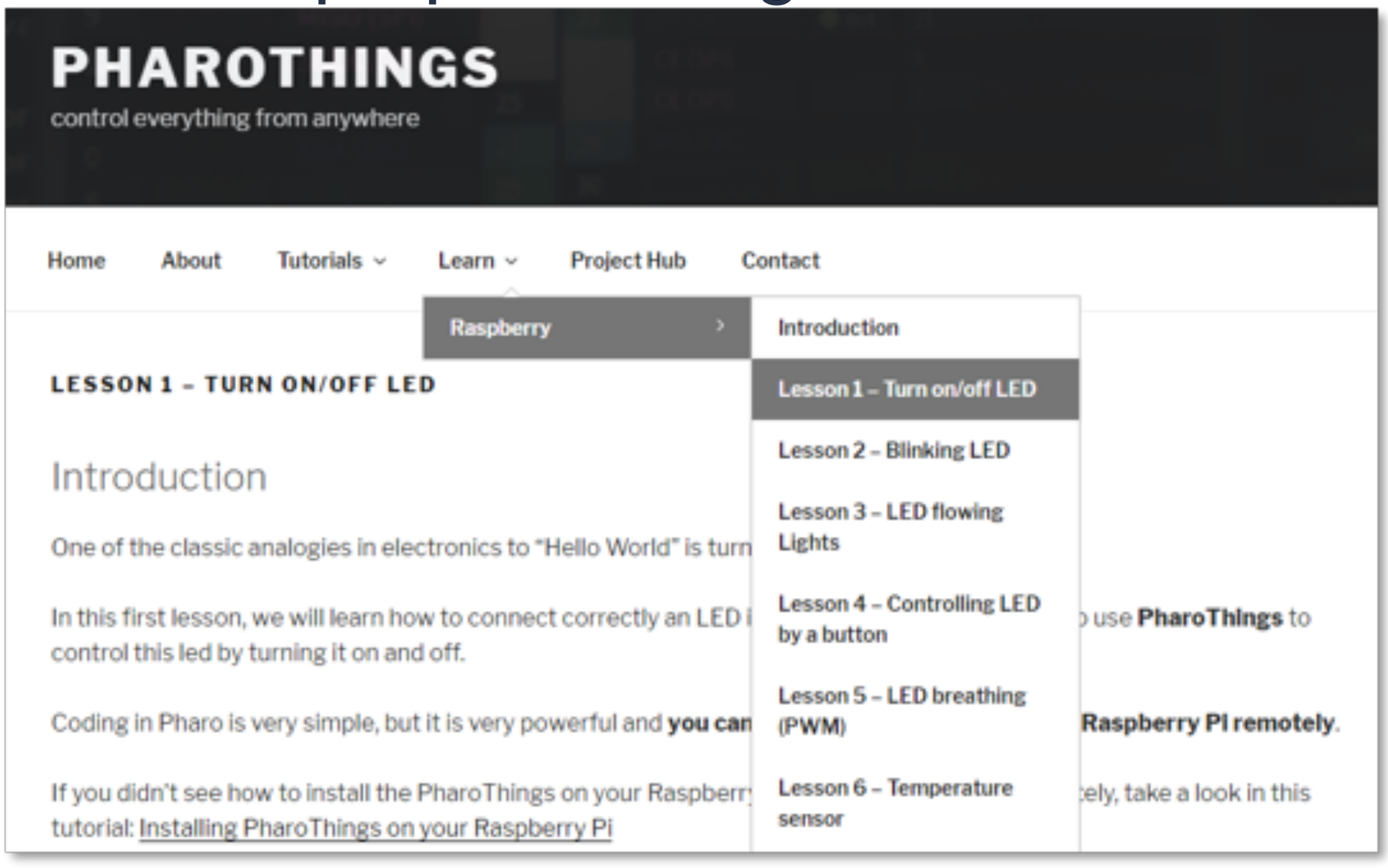
Middleware to manage the devices



5 - THE FUTURE

Website official with many lessons and tutorials

Draft: http://pharothings.allexoliveira.com.br



WITH PHAROTHINGS YOU CAN

- Dynamically update your running board
- Interact remotely with pins and boards
- Modify the system while it is running (create new board, change code)
- Make your changes persistent

Easy, powerful.

THANKS!

Any questions?

marcus.denker@inria.fr
allex.oliveira@msn.com

PRESENTATION INFORMATION

This slides was presented at ESUG 2018, in Cagliari, ITALY

- Title: Pharo IoT
- Presenters:
  Marcus Denker - marcusdenker.de / zweidenker.de
  Allex Oliveira - **www.linkedin.com/in/allex-oliveira**

ESUG conferences
http://www.esug.org/wiki/pier/Conferences
INRIA
https://www.inria.fr/
RMOD TEAM
https://rmod.inria.fr/web
PHARO PROJECT
https://github.com/pharo-project/pharo
PHAROTHINGS PROJECT
https://github.com/pharo-iot/PharoThings