

AMIES 2016 HERAKLION

Embedded applications in the domain of

- Agriculture
- Smart Homes

Author: Peter Mertens Thomas More Campus Geel Belgium

CONTENT

- **Embedded application in the domain of Smart Home:**

An embedded smart home connect to a KNX basic installation.

- **Embedded application in the domain of Agriculture:**

Measure the color and temperature of an algae breeder reactor in a greenhouse and create a temperature/humidity image of this greenhouse.

EMBEDDED SMART HOME

- **What is KNX?**

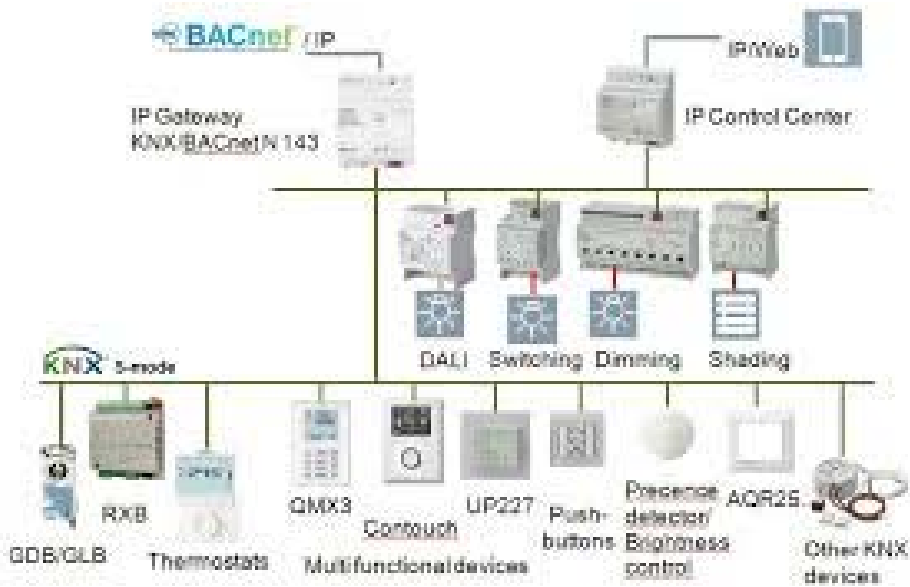
More convenience, comfort, more safety, higher energy savings: The demand for building management systems is continuously increasing.

**KNX - the Worldwide
STANDARD for Home and
Building Control**



EMBEDDED SMART HOME

Website KNX: <https://www.knx.org/>



KNX MEMBERS AT ISH 2015

AABB
AABB Automation Products GmbH
Booths 10.3 A 1

AFG Arminio
Fondur-Ribas GmbH
Booths 8.0 E 5

AIKMASTER®
AIKMASTER A/S
Booths 11.1 C 1 B

ALCANTARA
ALCANTARA Design Services GmbH
Booths 10.3 D 33

BELIMO
BELIMO Automation AG
Booths 10.2 C 5

BENTON & BOWLES
Bentley & Partners Ltd.
Booths 10.2 A 71

BOSCH
Bosch Thermotechnik GmbH
Booths 8.0 B 2

B/S/H/

BSD Bosch und Siemens Hausgeräte GmbH

CAREL
Carel Deutschland GmbH
Booths 11.0 D 16

CIAT
CIAT Italia SRL
Booths 10.2 B 16

DÄIKIN
Daikin Europe N.V.
Booths 8.0 E 14

Data Design Systems®
Data Design System GmbH
Booths 11.1 D 29

DEUTA GROUP
Deuta Drive Schöner GmbH
Booths 10.3 A 21

EMPHLE
Emphle Controls GmbH
Booths 10.1 A 11

elka
ELKA-Electronic GmbH
Booths 10.3 B 59

elsner
ELSNER SYSTEMS
Elsner Elektronik GmbH
Booths 10.3 C 71

Eltel GmbH
Booths 10.2 B 71

ENVIROTEC
ENVITEC Controls GmbH
Booths 10.3 A 49

EPH Controls
Booths 10.3 A 49

Estimatec Technology GmbH
Booths 10.1 B 91

Franken-Automation GmbH
Booths 8.1 E 46

function technology AG
function Technology AS
Booths 10.3 A 47

G&P
G&P Kunststofftechnik GmbH
Booths 11.1 B 91

HELIO-THERM
HELIOTHERM Wärmepumpen-Systeme GmbH
Booths GALL H 02

HERMAGIS
HERMAGIS AG
Booths 10.3 A 55

ICONAG
ICONAG Lowachse GmbH
Booths 10.3 A 41

Zappas Industries
IRCA S.p.A.
Booths 7.0 B 68

ise
Ise GmbH
Booths 10.3 A 49

Bartheim
Jost Bartheim GmbH & Co. KG
Booths 3.0 D 44

KERN
Kern GmbH
Booths 3.1 A 61

LARS
LABS Andral Systems GmbH
Booths 10.3 B 48

LOTTECO
LOTTECO-electronics GmbH
Booths 10.3 C 57

menerg
Menerg GmbH
Booths 11.1 C 21

menred
Menred Controls System (Tweining) Co., Ltd.
Booths 11.1 A 72

Möhlertech
Möhlertech GmbH
Booths 10.1 A 19

NXT
NXT GmbH
Booths 10.3 C 31

NZB Nordwestdeutsche Zylinderwerke - Ing.-Ag.
Essener GmbH & Co. KG
Booths 10.2 C 19

Obermaier GmbH & Co. KG
Booths 10.1 A 29

Panasonic Marketing Europe GmbH
Booths 7.0 E 99

Pfennigsmühle GmbH
Booths 8.0 B 14

Rensong Ventilation me
Booths 11.1 C 45

Schneider Electric GmbH
Booths 10.1 A 11

SIEMENS
Siemens AG
Booths 10.2 C 55

Siemens Schweiz AG
Booths 10.2 A 45

Sinapsi
Sinapsi GmbH
Booths 10.2 A 49

Sontag
Sontag AG
Booths 10.3 A 61

STERN
STERN GmbH
Booths 8.0 B 48

THERMO KLIMA
Thermoklima GmbH
Booths 10.3 A 39

thoben
Thoben AG
Booths 10.3 A 41

thermotek
Thermotek Sensor Technik GmbH
Booths 10.3 A 39

UPONOR
Uponor GmbH
Booths 8.0 E 79

Vallée
Vallée Deutschland GmbH & Co. KG
Booths 8.0 B 43

VIERER
Vierer AG & Co.
Booths 10.2 D 38

Viega
Viega GmbH & Co. KG
Booths 8.0 A 44

VIEHMANN
Viehmann Werke GmbH & Co. KG
Booths 8.0 B 74

WAGO Kontakttechnik GmbH & Co.
Booths 8.0 B 31

WAIREMA
WAIREMA Technik SE
Booths 10.3 A 49

WEINZER
Weinzinger Engineering GmbH
Booths 10.3 A 49

wieland
Wieland Electric GmbH
Booths 10.2 C 15

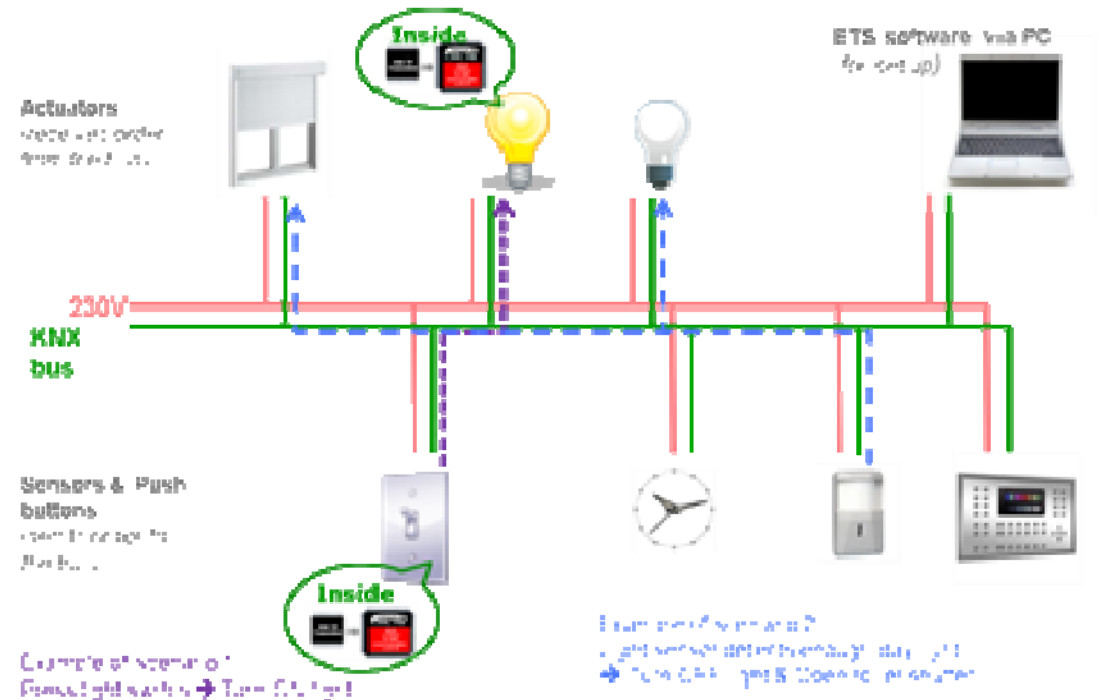
Wolf
Wolf GmbH
Booths 8.0 F 14

KNX
www.knx.org
Booth: 10.3 A 49

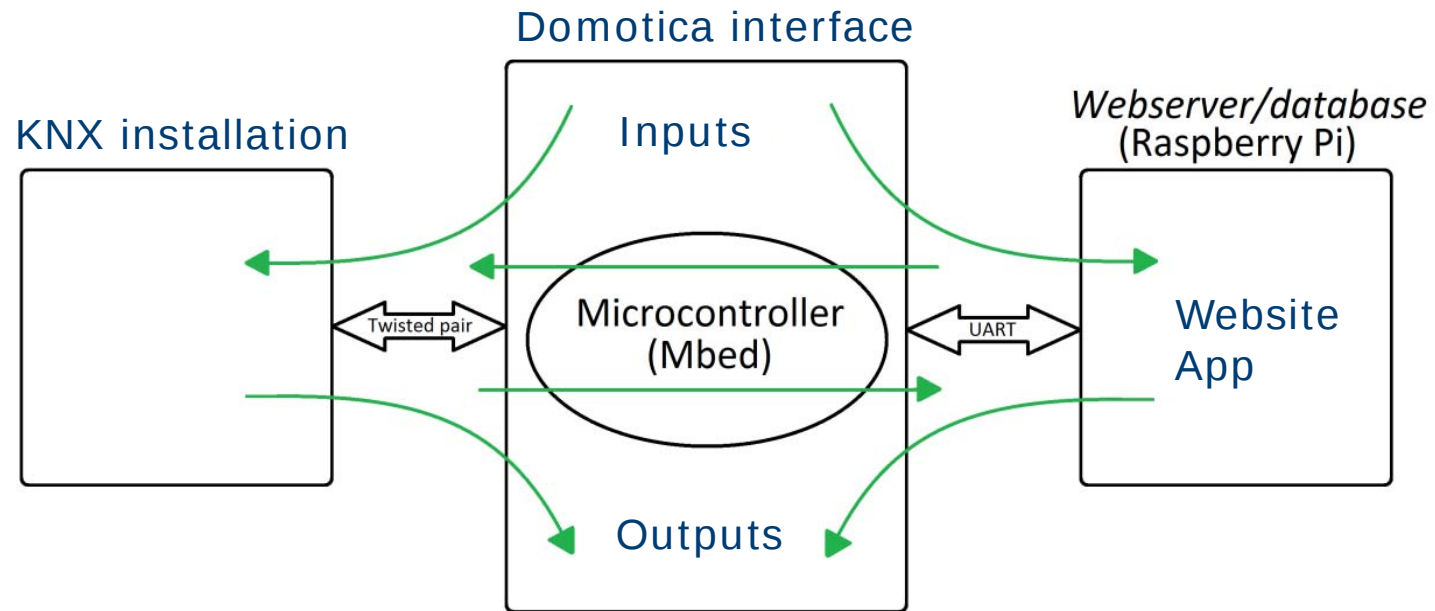
EMBEDDED SMART HOME

- KNX architecture

- ETS software
- Decentral system
- Bus system
- Sensors/ Actuators
- Web services
- Remote Control

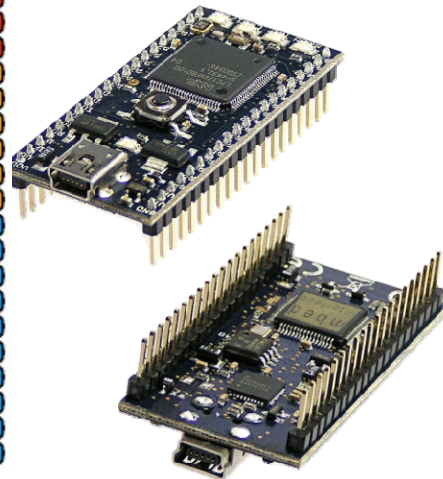
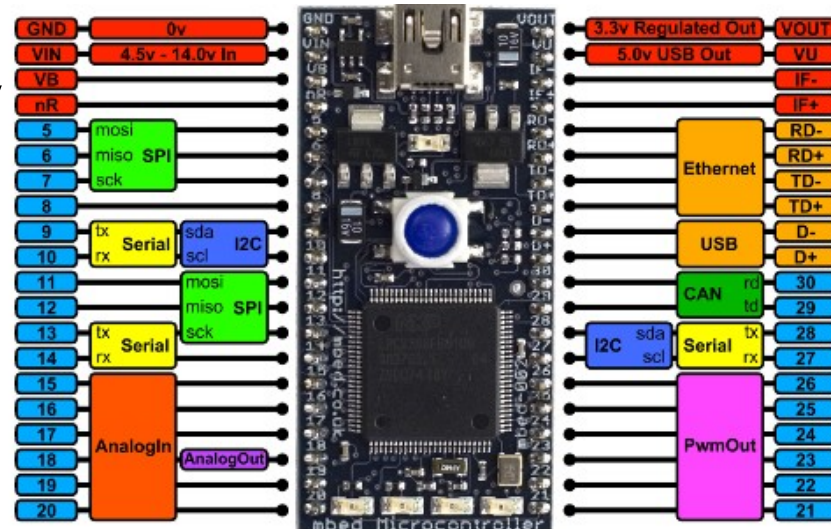


EMBEDDED SMART HOME



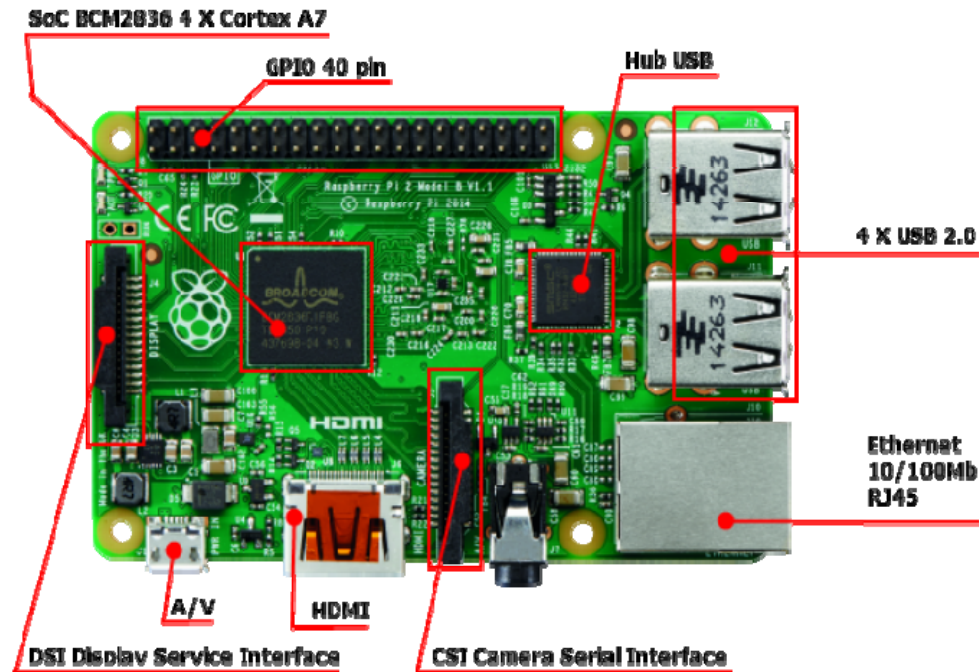
KNX INTERFACE EXAMPLE 1

- Realization with Arm μ controller and Rasp. PI
- Embedded platform NXP LPC1768
 - 32-bit ARM-controller
- 2MB Onboard Flash-memory
 - USB-device
- Many hardware interfaces



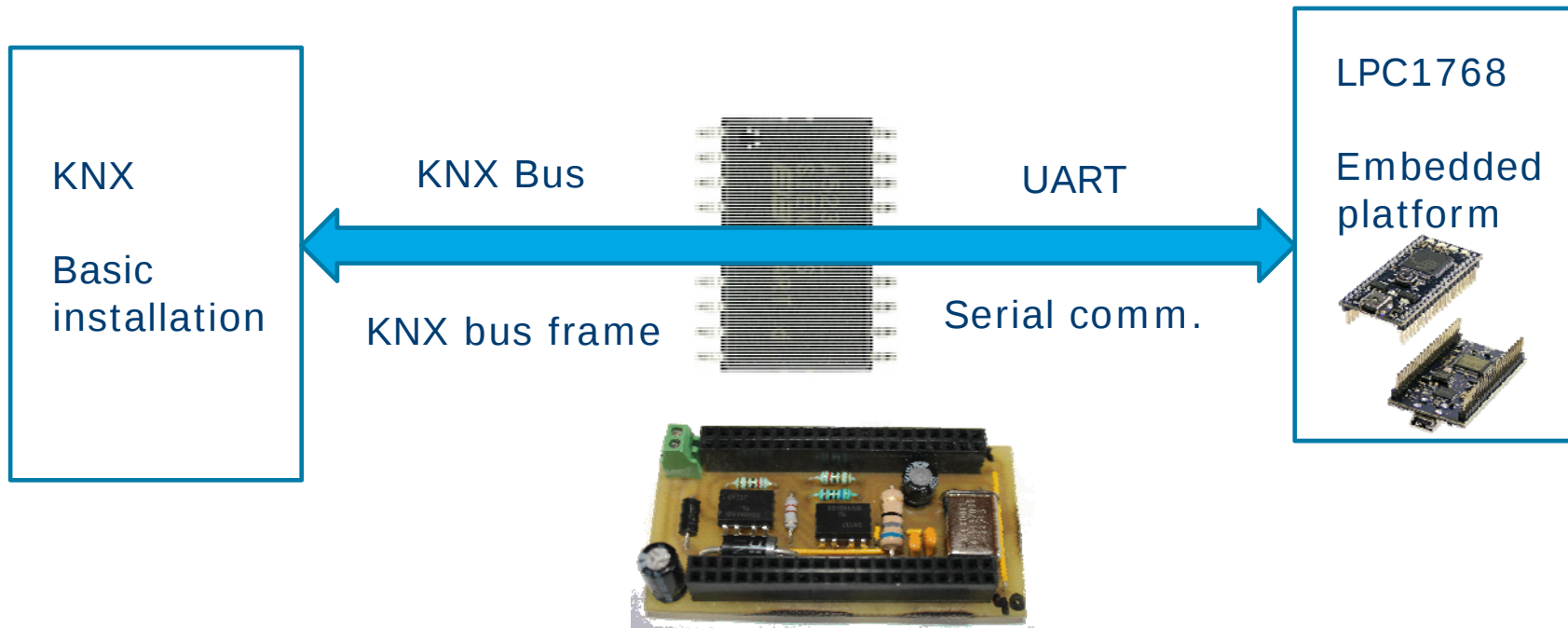
KNX INTERFACE EXAMPLE 1

- Webserver Raspberry Pi 2 with WIFI stick:

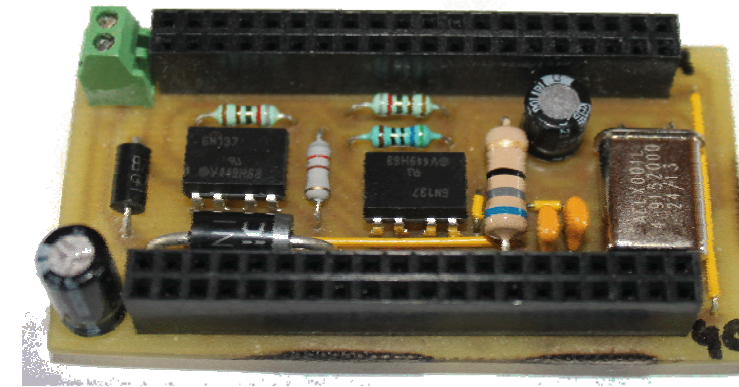
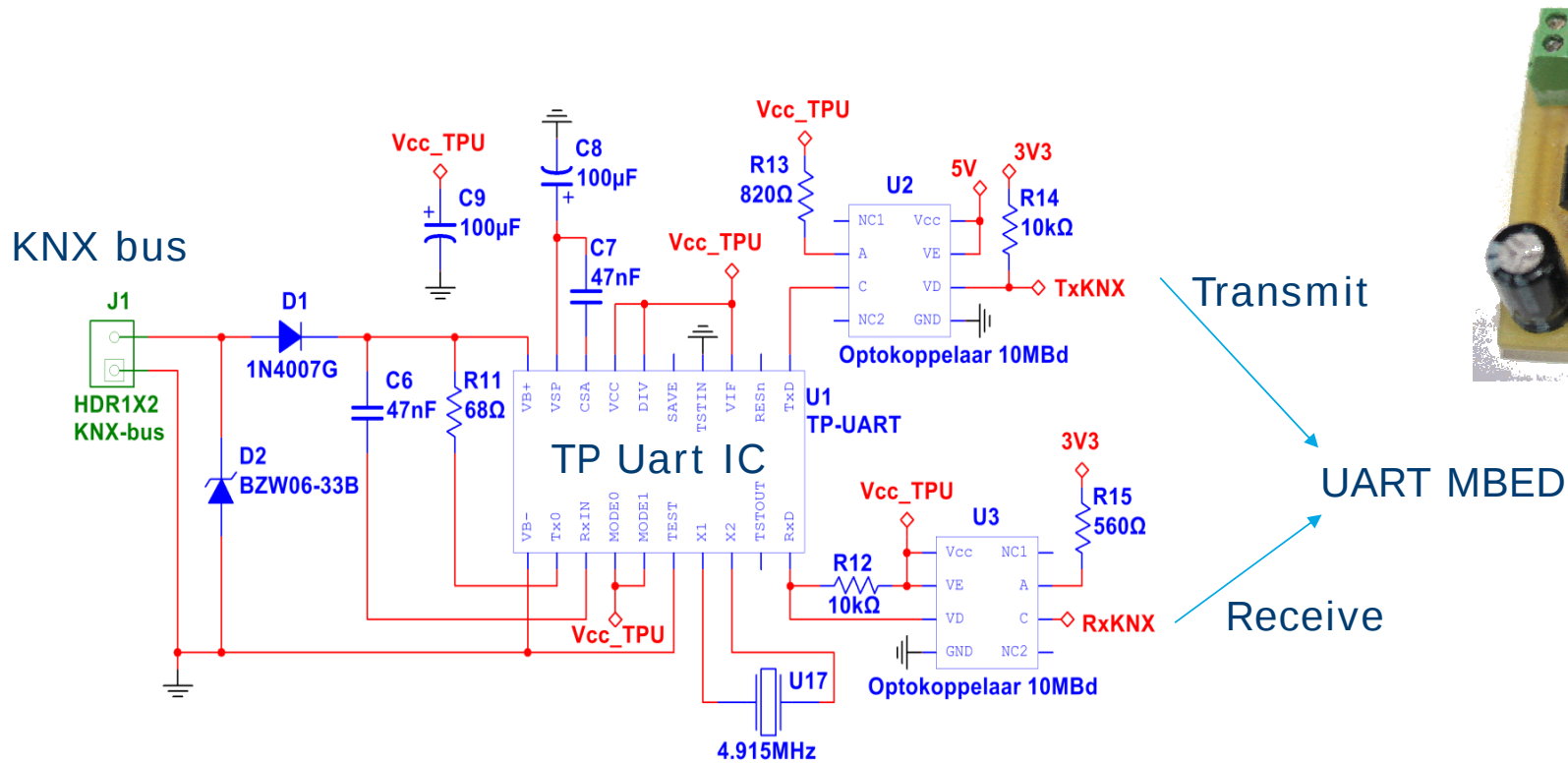


KNX INTERFACE EXAMPLE 1

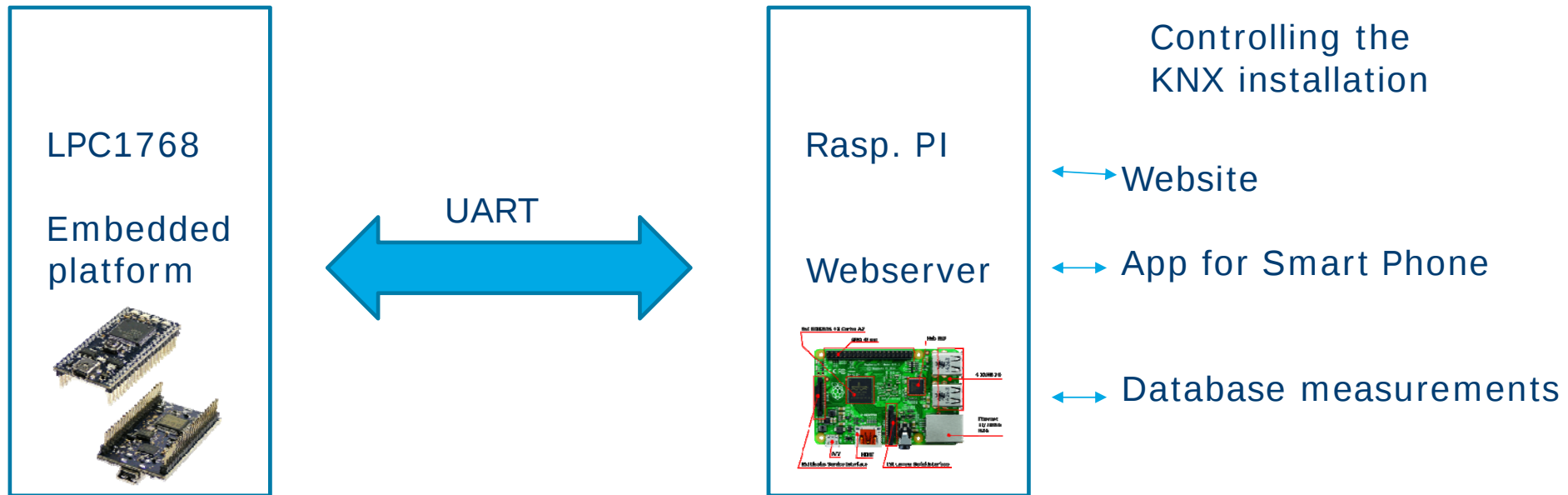
- Interface KNX – embedded system
 - Siemens TP-UART-IC



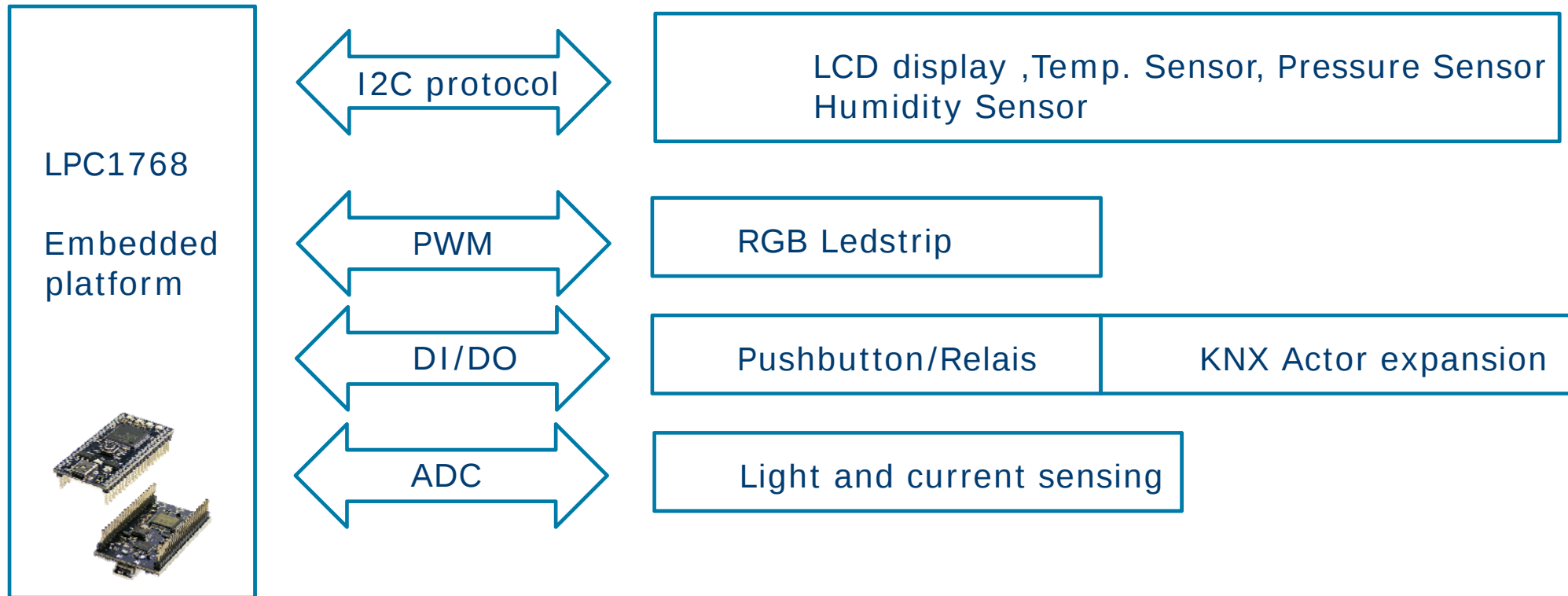
KNX INTERFACE EXAMPLE 1



WEBSERVER INTERFACE

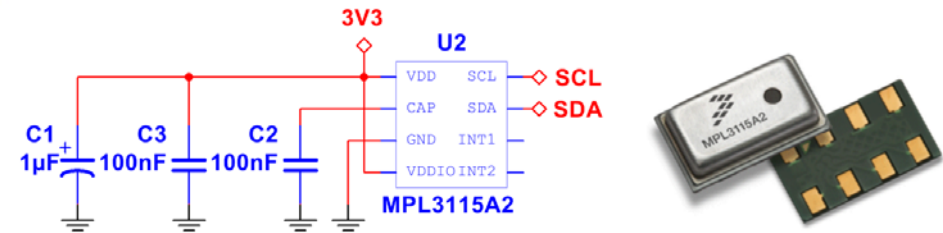
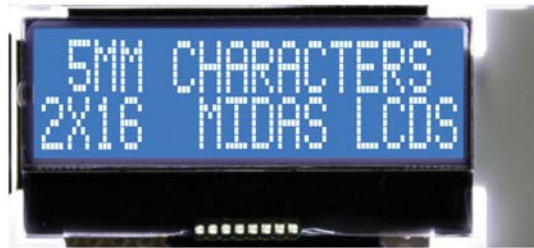


SENSOR INTERFACE

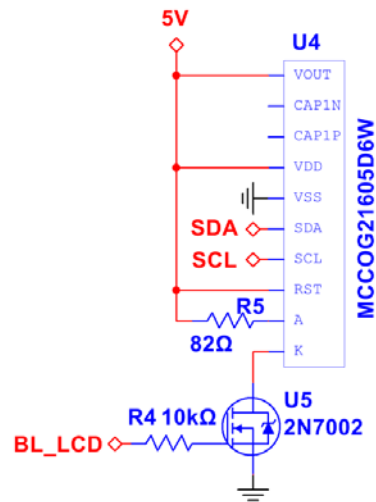


SENSOR INTERFACE

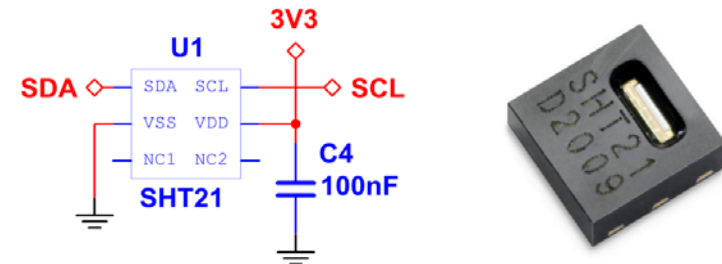
LCD screen
Temp. Sensor
Pressure Sensor
Humidity Sensor



Pressure/Temp Sensor

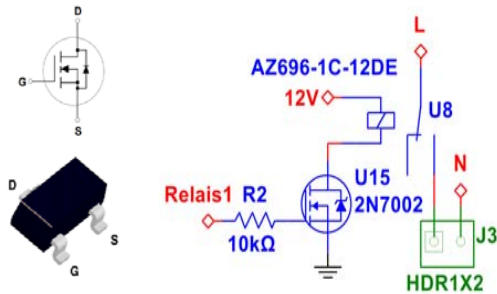


LCD Display



Humidity Sensor

SENSOR INTERFACE



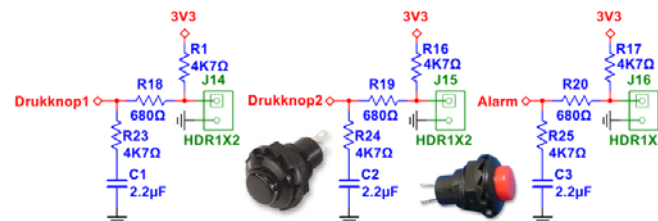
Relais



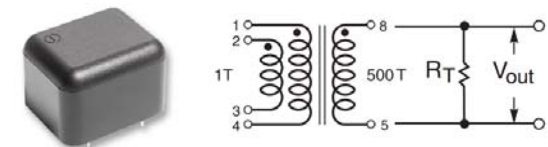
Light sensor



RGB Ledstrip

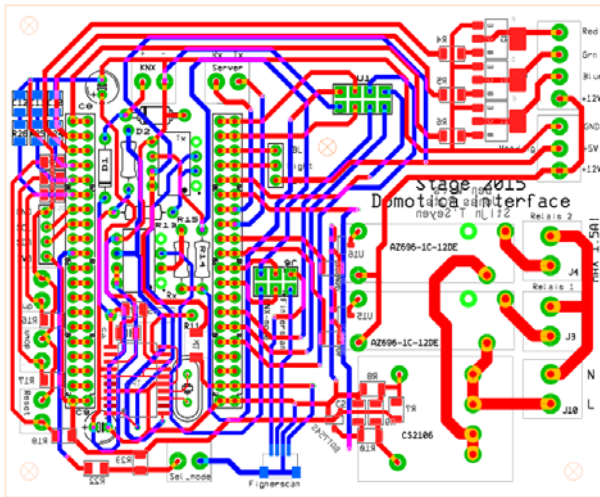


Pushbutton

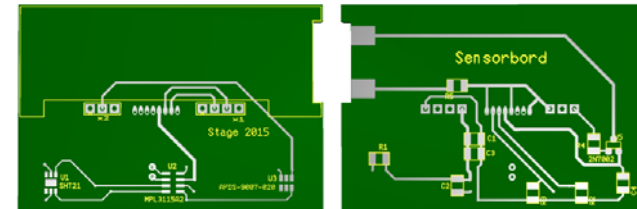
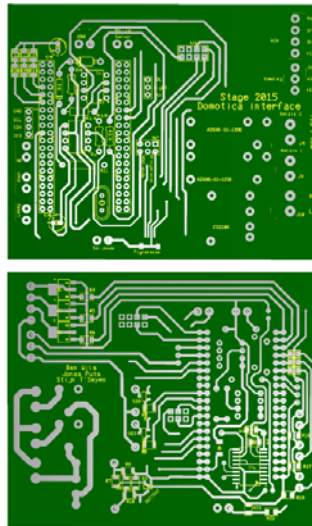


Current sensor

HARDWARE PCB'S

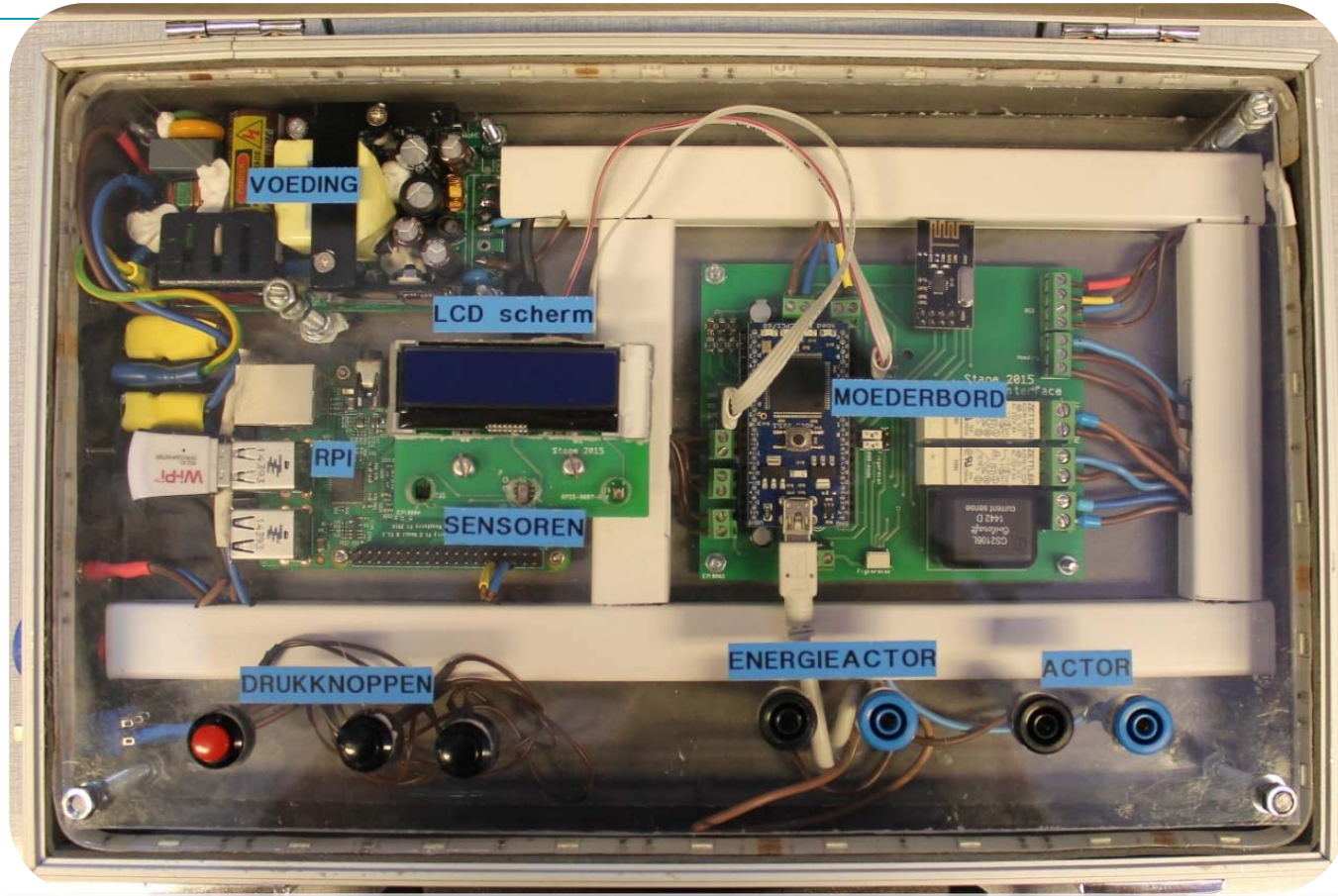


Mother board

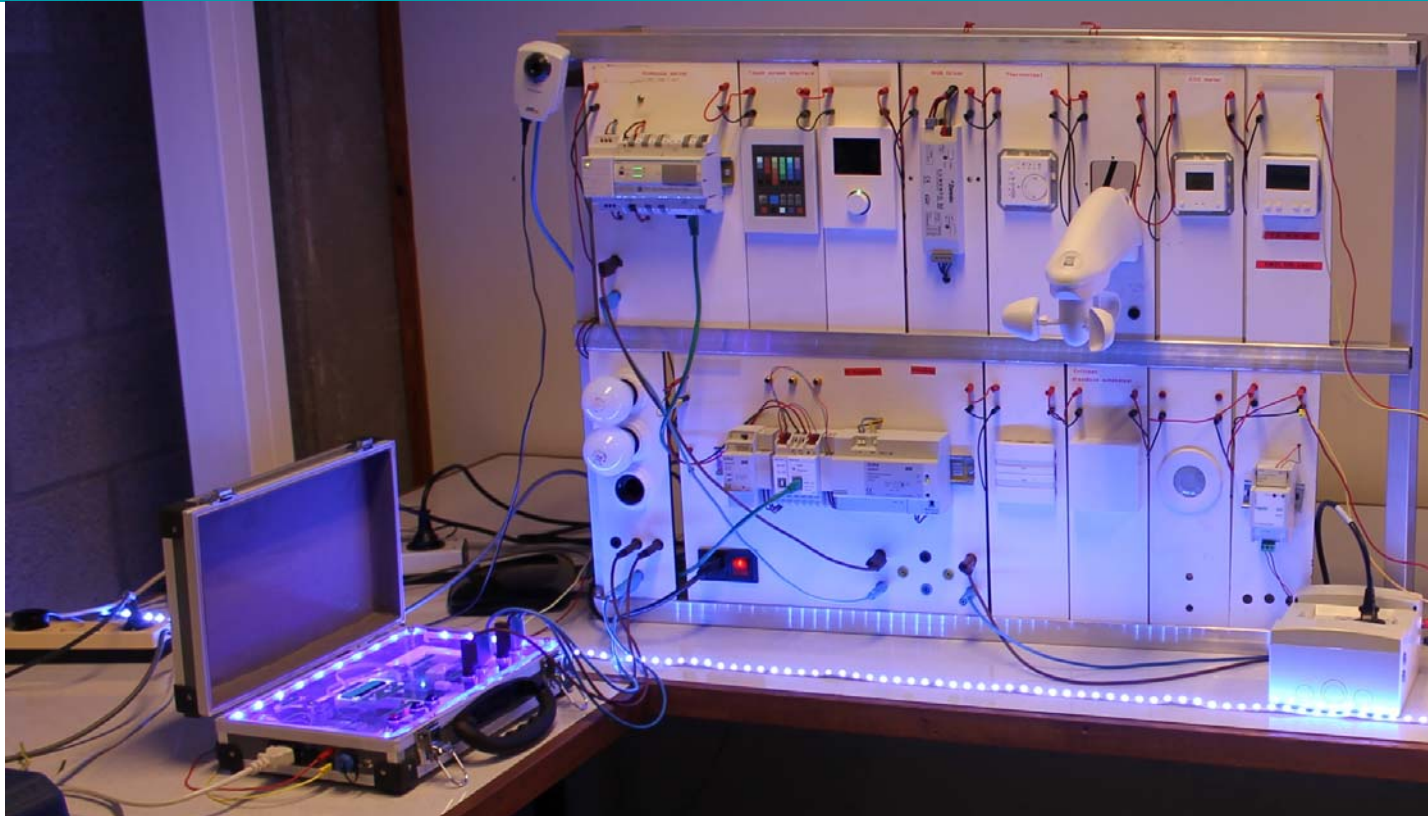


Sensor print

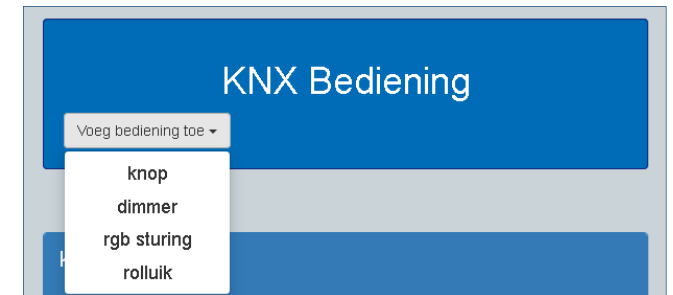
HARDWARE REALIZATION IN A SUITCASE FOR EDUCATIONAL PURPOSE



EDUCATIONAL SETUP



SCREENSHOT WEBSITE / APP ON SMART PHONE



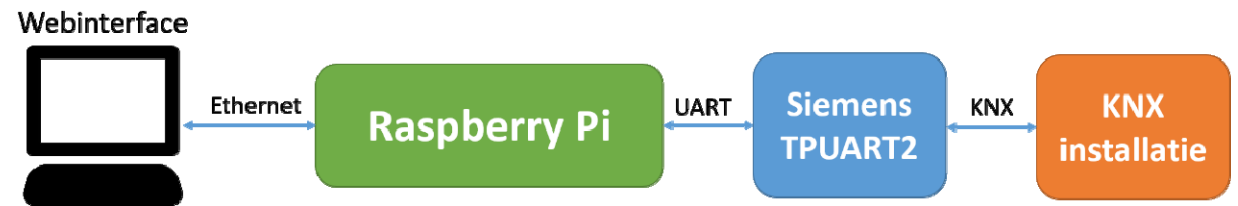
KNX INTERFACE EXAMPLE 2

- Webbased
- PC / Mobiel / ...
- Simple
- Stabel



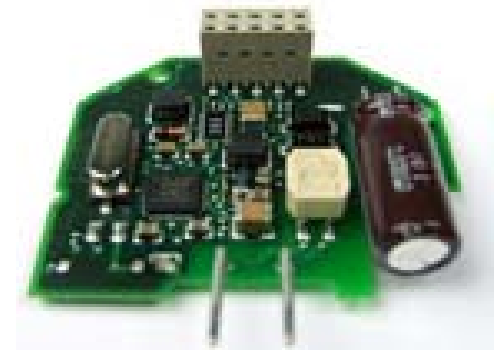
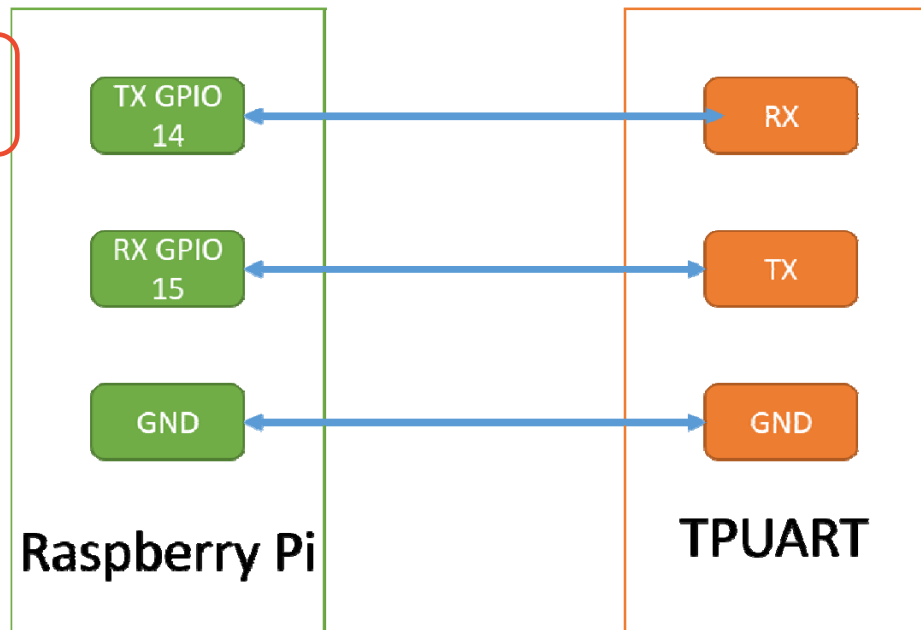
KNX INTERFACING

- Raspberry Pi
- KNX interfacing
- Bidirectionele com.
- Com. Webinterface
- Python codes
 - Library
 - Main code

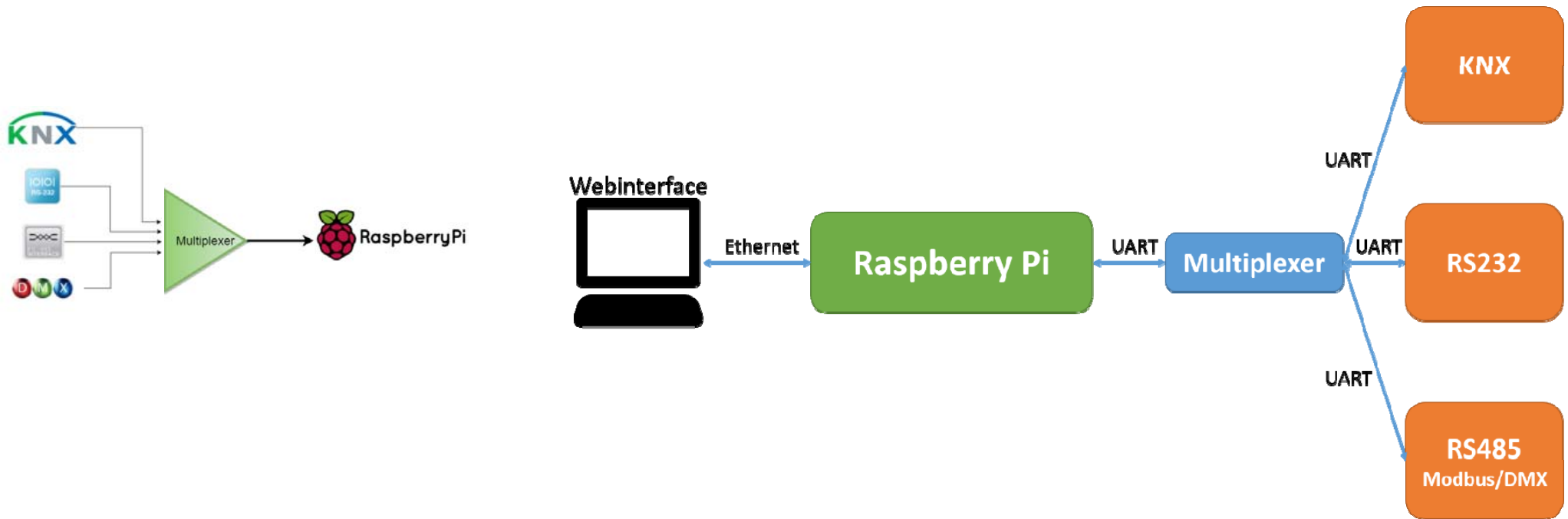


TPUART MODULE

Pin#	NAME	NAME	Pin#
01	3.3v DC Power	DC Power 5v	02
03	GPIO02 (SDA1 , I2C)	DC Power 5v	04
05	GPIO03 (SCL1 , I2C)	Ground	06
07	GPIO04 (GPIO_GCLK)	(TXD0) GPIO14	08
09	Ground	(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)	(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)	Ground	14
15	GPIO22 (GPIO_GEN3)	(GPIO_GEN4) GPIO23	16
17	3.3v DC Power	(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)	Ground	20
21	GPIO09 (SPI_MISO)	(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)	(SPI_CE0_N) GPIO08	24
25	Ground	(SPI_CE1_N) GPIO07	26
27	ID_SD (I2C ID EEPROM)	(I2C ID EEPROM) ID_SC	28
29	GPIO05	Ground	30
31	GPIO06	GPIO12	32
33	GPIO13	Ground	34
35	GPIO19	GPIO16	36
37	GPIO26	GPIO20	38
39	Ground	GPIO21	40

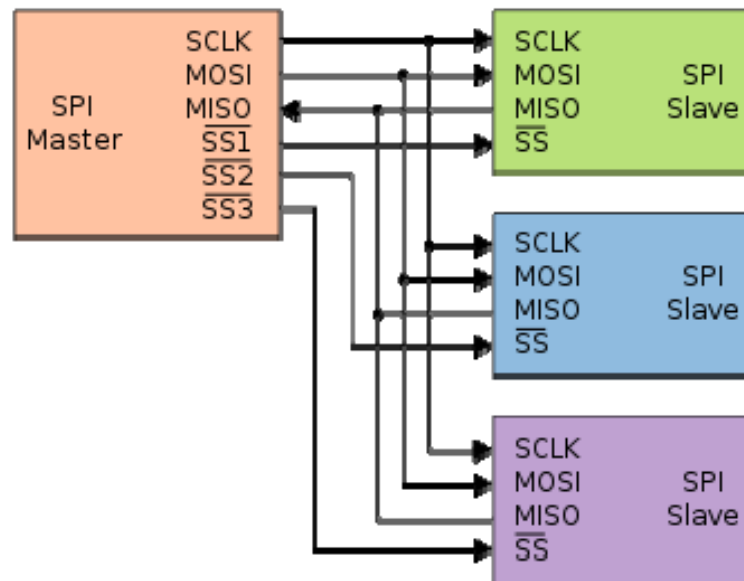


MORE INTERFACES (MULTIPLEXER)



MULTIPLEXER SETUP

RPI interface

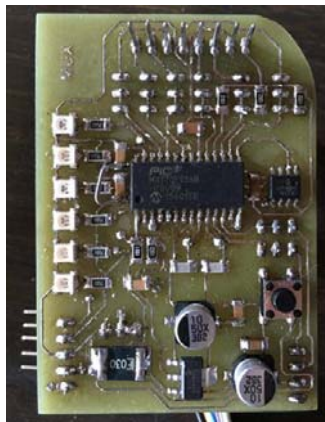


KNX interface

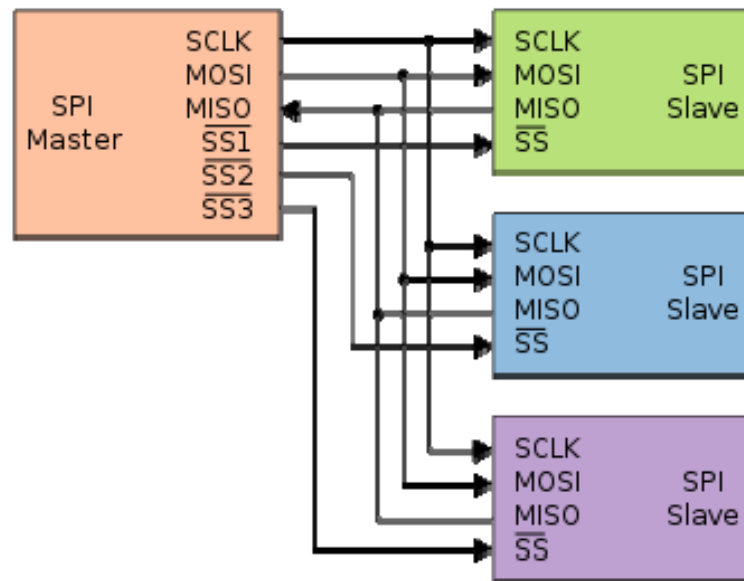
DMX, MODUS, RS 485

RS 232

HARDWARE REALIZATION



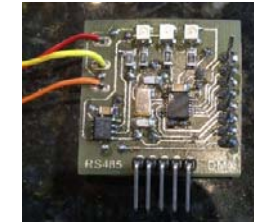
RPI interface



KNX interface



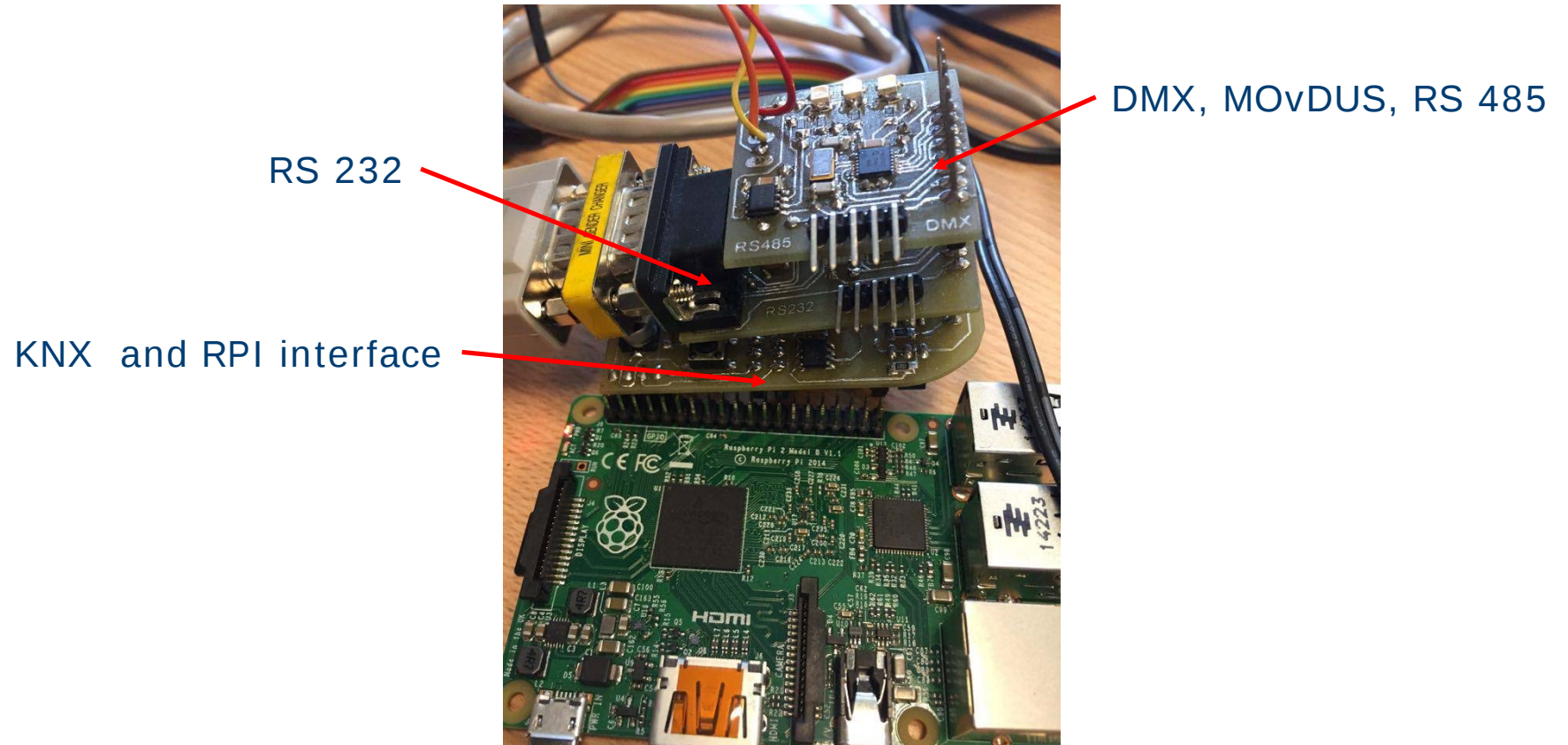
DMX, MODUS, RS 485



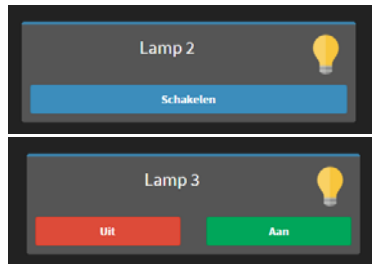
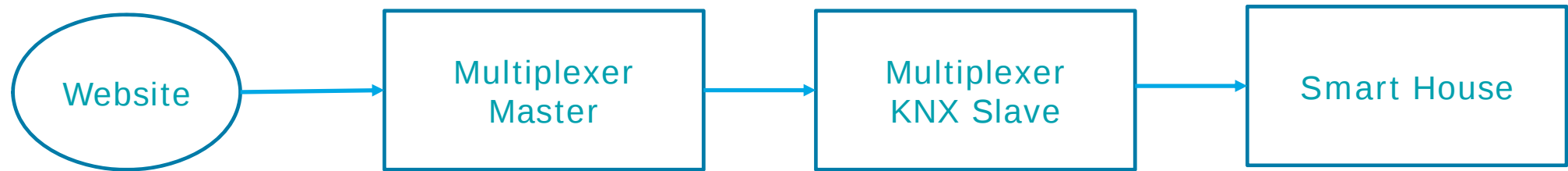
RS 232



HARDWARE REALIZATION



PRACTICAL



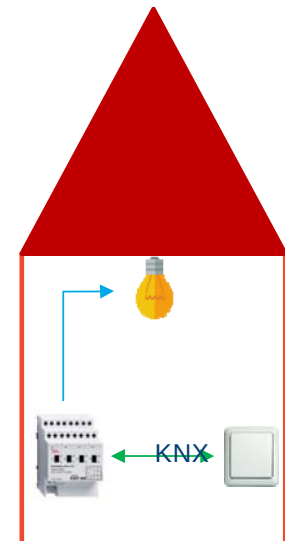
Raspberry Pi

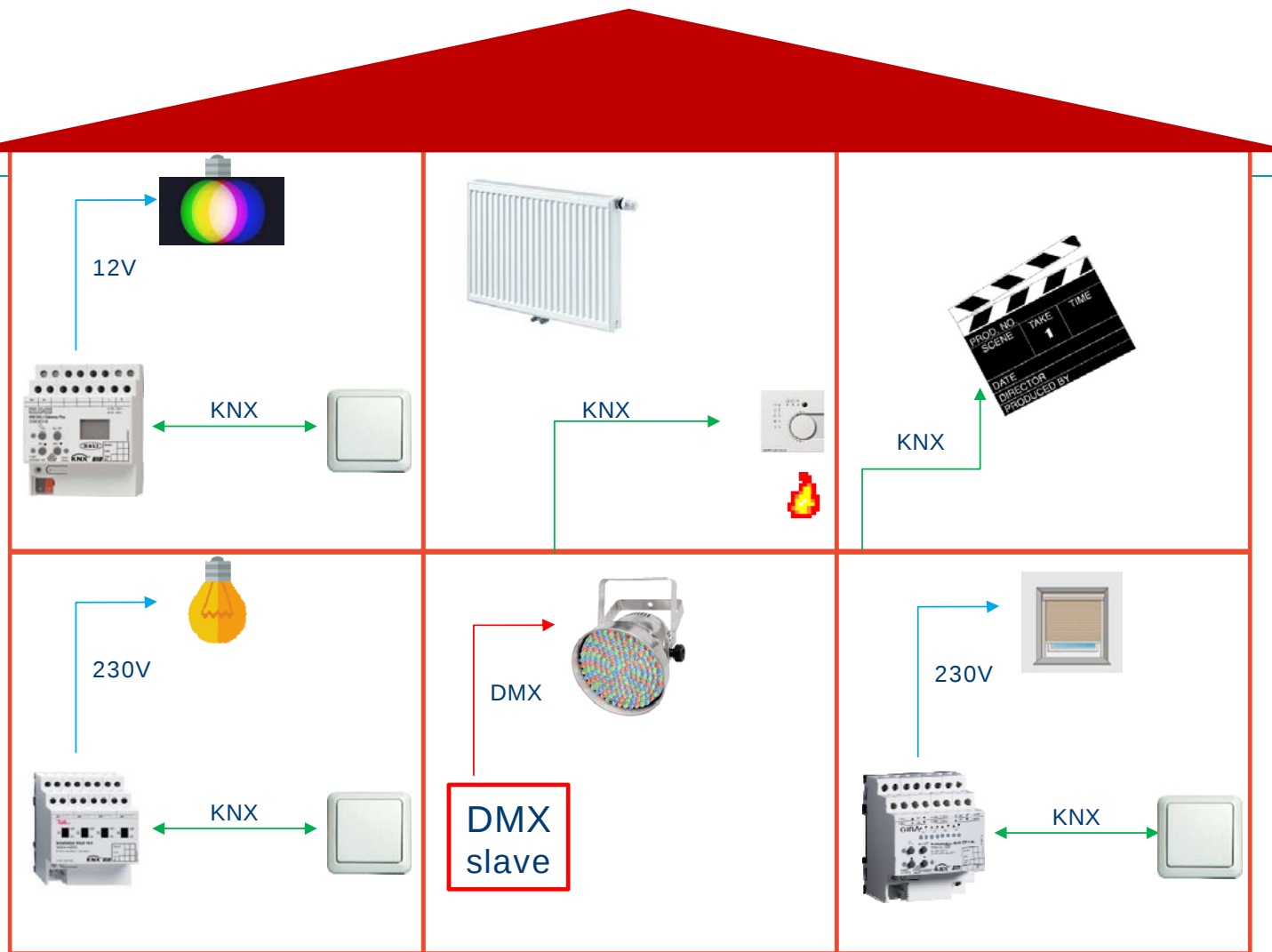


Multiplexer



Multiplexer Slave
TP UART IC

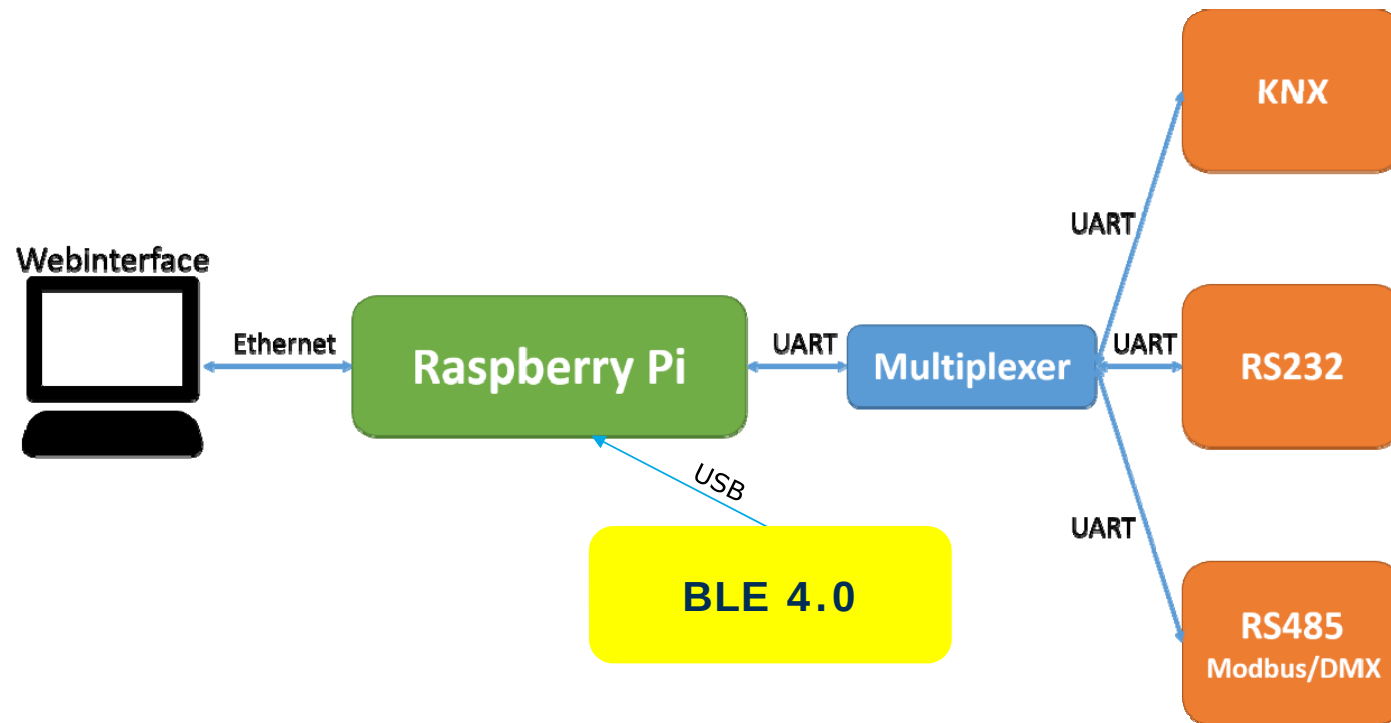




- 1 : 1 bit – schakelen/rolluik/...
- 3 : 4 bit – Relatief dimmen/rolluik/...
- 5 : 8 bit - % dimmen/rolluik/waarde/...
- 9 : 16 bit float – temperaturen/...
- 17 : 8 bit – scene oproepen
- 18 : 8 bit – scene oproepen + aanpassen
- 232 : 24 bit – RGB led

DMX, RS232, ...

BLUETOOTH LOW ENERGY



BLEUTOOTH LOW ENERGY

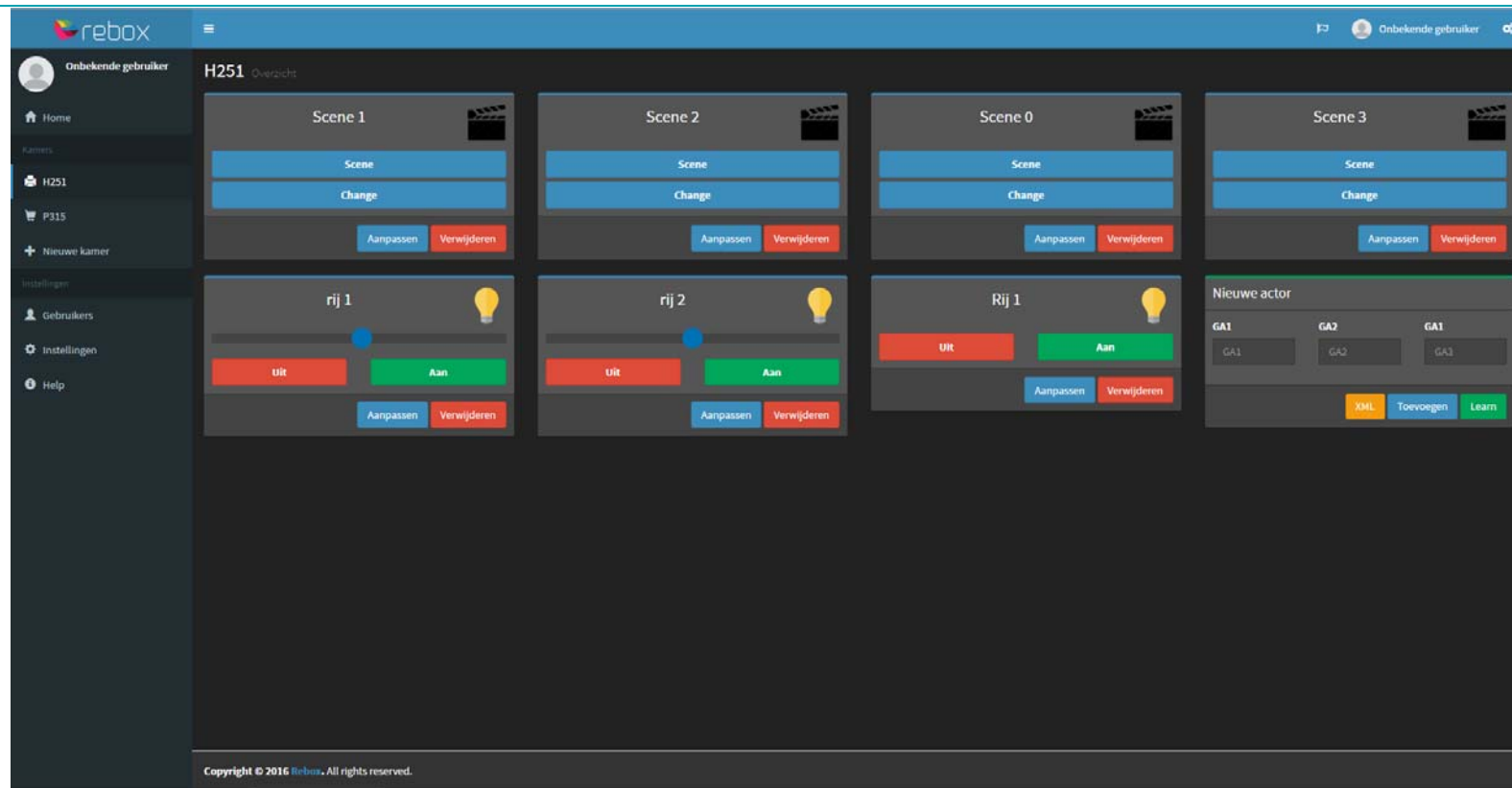


WEBINTERFACE

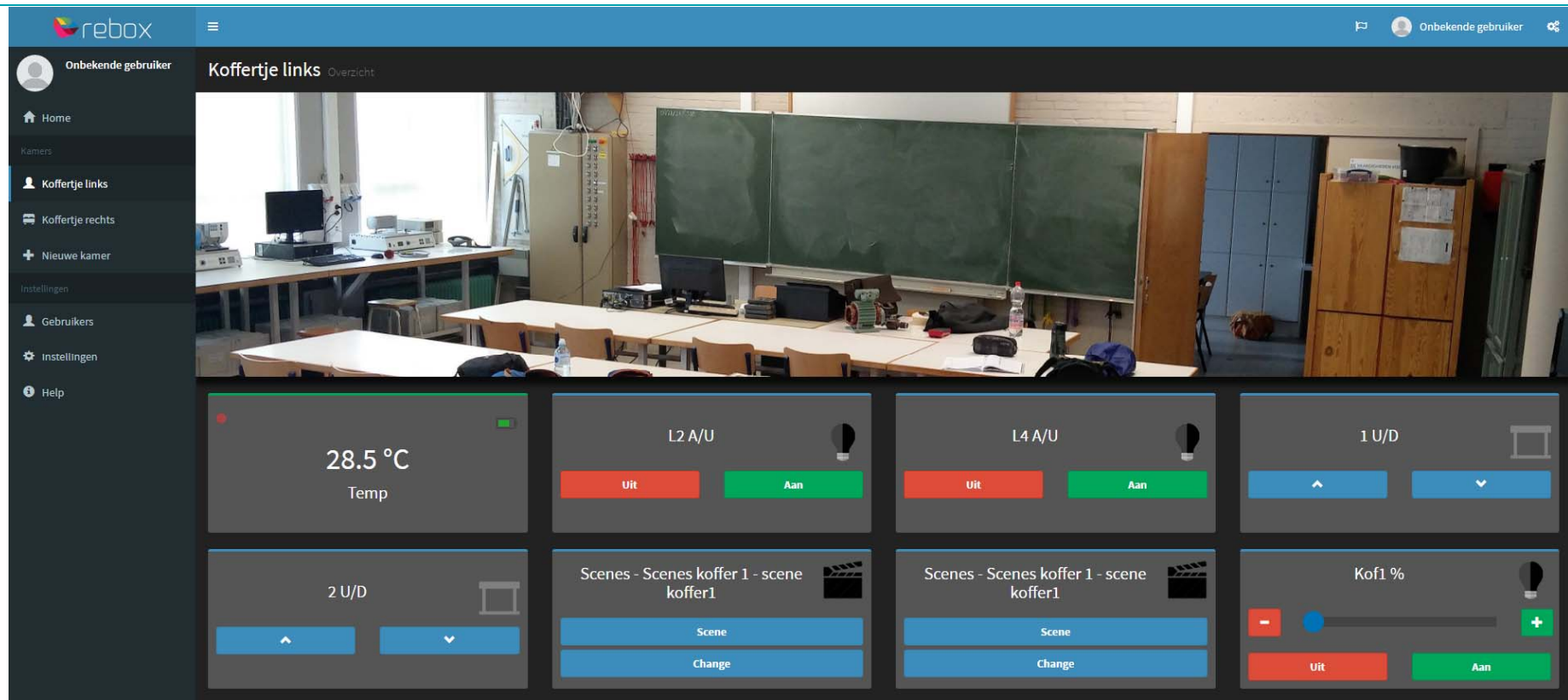
The screenshot displays the Rebox SmartLink web interface. The top navigation bar is blue with the 'rebox' logo on the left and a user profile icon labeled 'Onbekende gebruiker' on the right. A dark sidebar on the left contains navigation links: Home, Kamers, Keuken, Nieuwe kamer, Instellingen, Gebruikers, and Help. The main content area has a dark background. At the top, it shows 'Rebox SmartLink Overzicht'. Below this, a weather section for 'Dormansland' displays 'Gedeeltelijk bewolkt' with a sun and cloud icon, and details: 'Gedeeltelijk bewolkt. Maximaal 12°C. Wind uit het N van 15 tot 30 km/u.' and 'Locatie minder nauwkeurig'. To the right, a forecast table shows temperatures for 'Vandaag', 'Morgen', and 'Overmorgen'. Below the weather, a 'Keuken' (Kitchen) card features an Apple logo, the text 'Keuken' and 'Rebox', and a blue button labeled 'Ga naar kamer'.

Weer voor Dormansland	Vandaag	Morgen	Overmorgen
 Gedeeltelijk bewolkt Gedeeltelijk bewolkt. Maximaal 12°C. Wind uit het N van 15 tot 30 km/u. Locatie minder nauwkeurig	 12°C 11°C	 16°C 11°C	 18°C 9°C

WEBINTERFACE



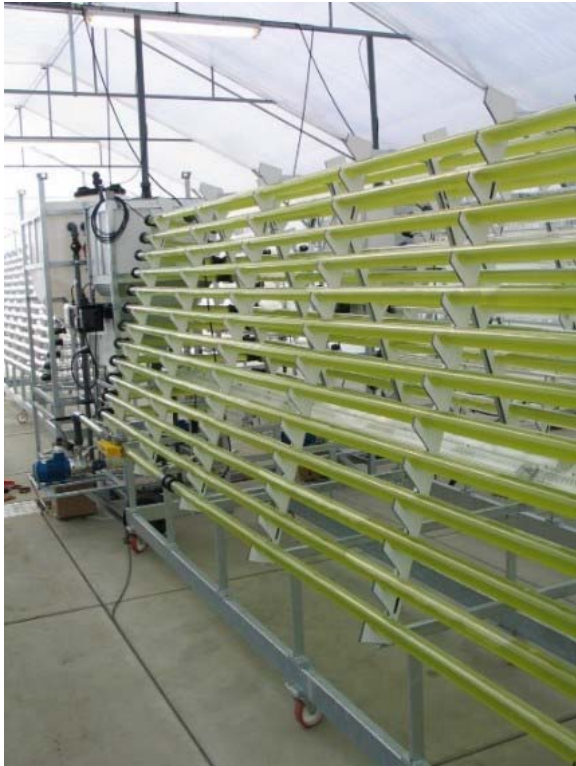
WEBINTERFACE



EMBEDDED GREENHOUSE APPLICATION

- Measure the color and temperature of an algae breeder reactor in a greenhouse and create a temperature image of this greenhouse.

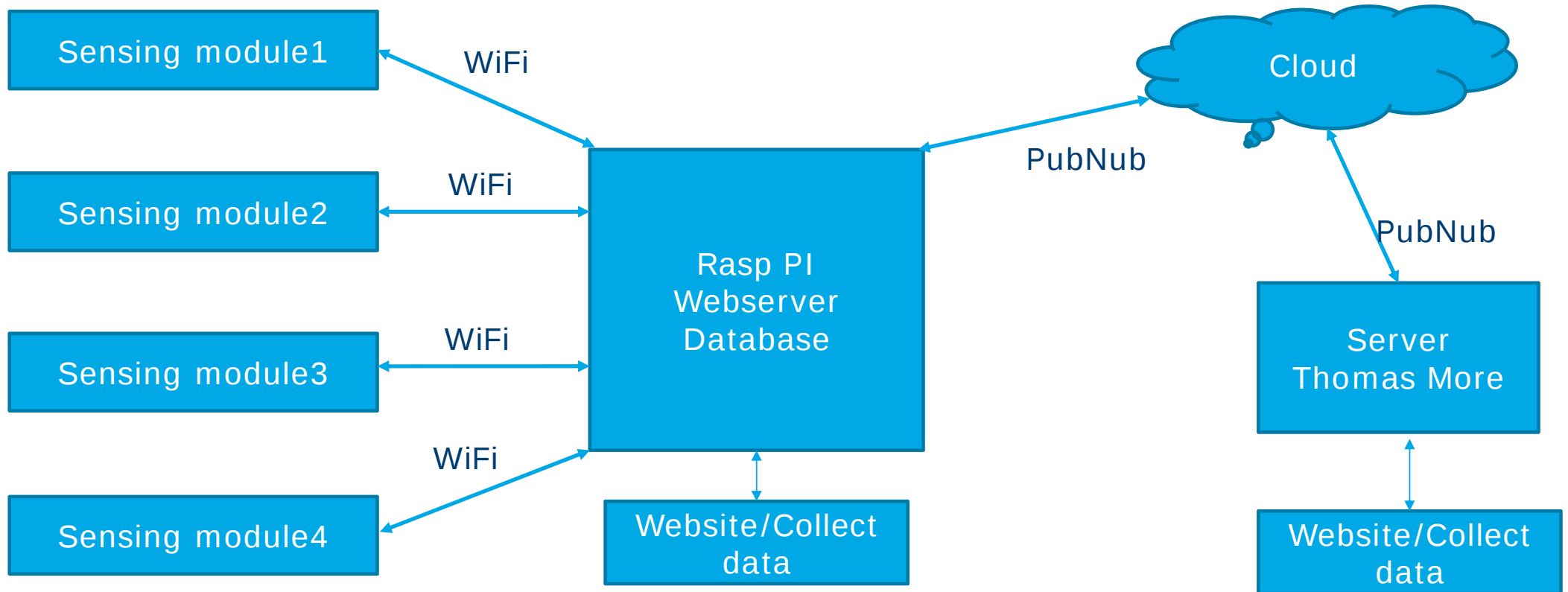
EMBEDDED GREENHOUSE APPLICATION: ALGAE



EMBEDDED GREENHOUSE APPLICATION: ALGAE

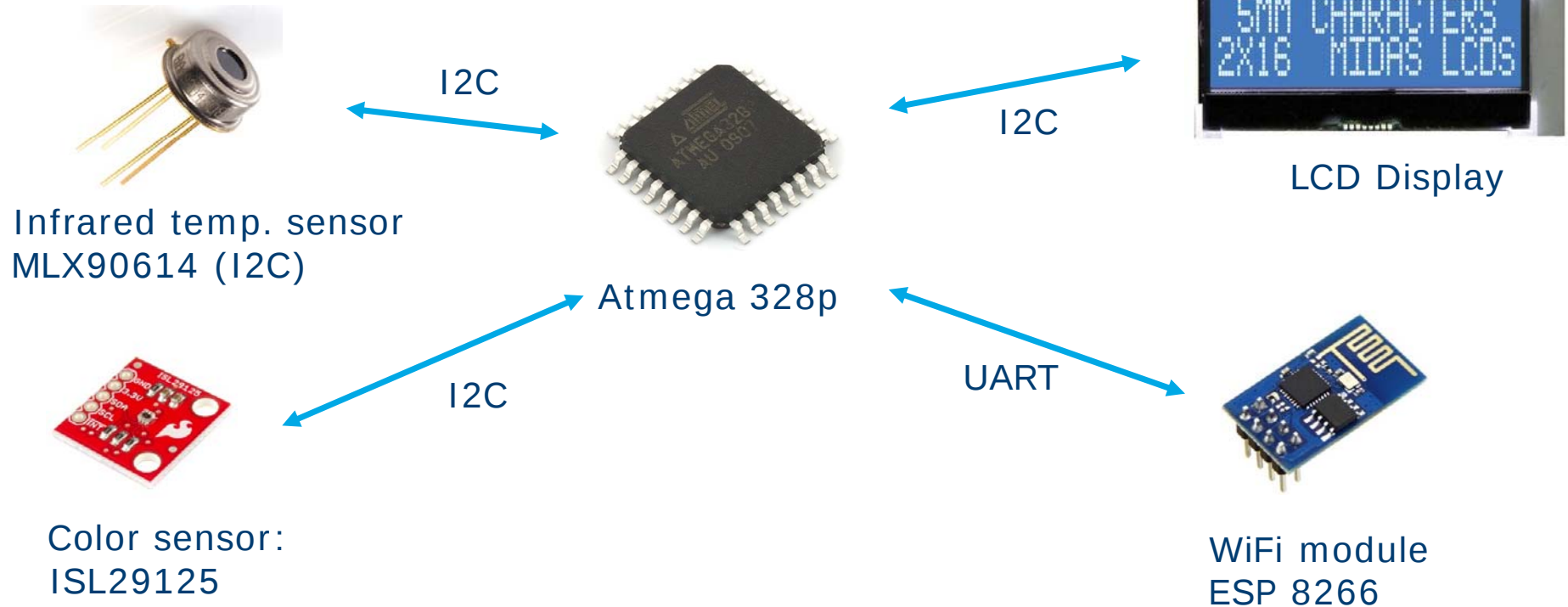
- Algae need very specific growing conditions
 - Light (RGB) and temperature important parameters
- Outlet in food, animal feed and the chemical sector

EMBEDDED GREENHOUSE APPLICATION: ALGAE



EMBEDDED GREENHOUSE APPLICATION: ALGAE

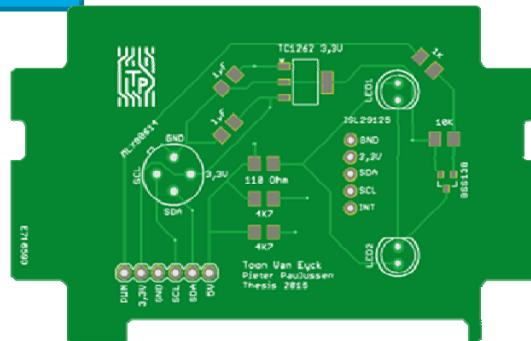
Sensing module Components



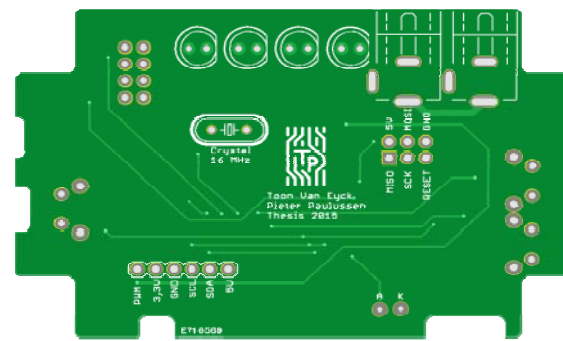
EMBEDDED GREENHOUSE APPLICATION: ALGAE

Sensing module Hardware

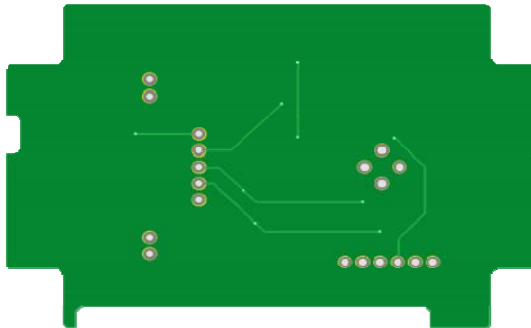
TOP



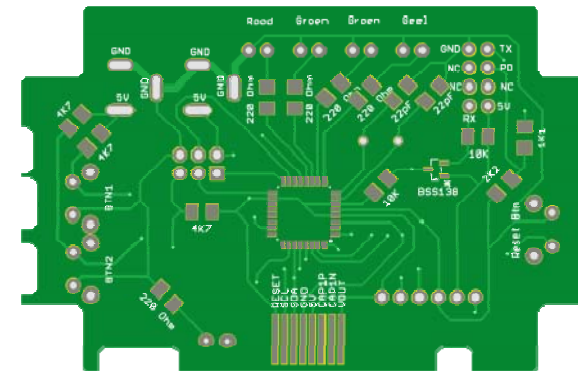
TOP



Bottom

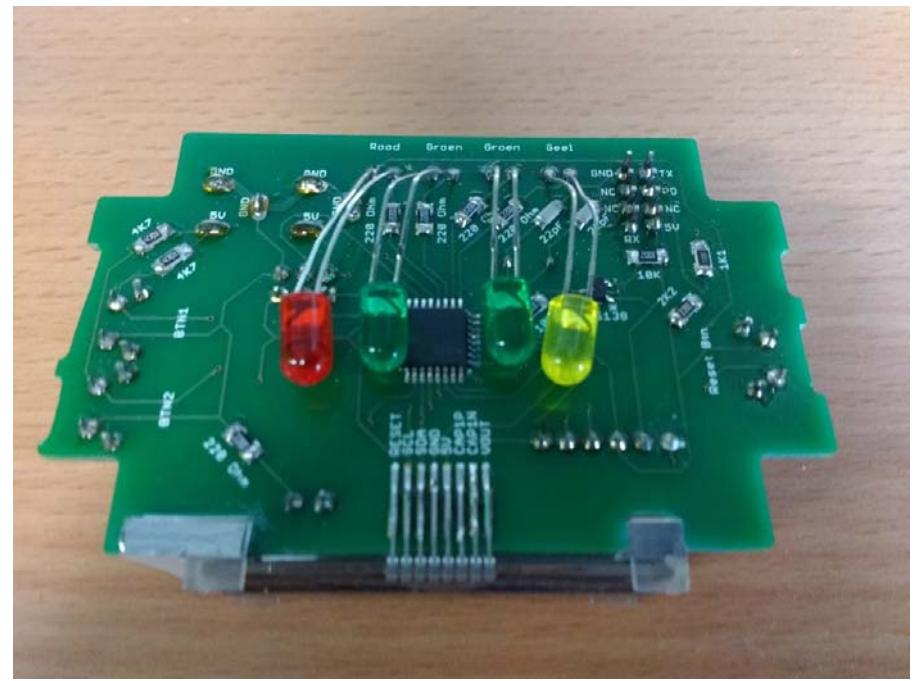
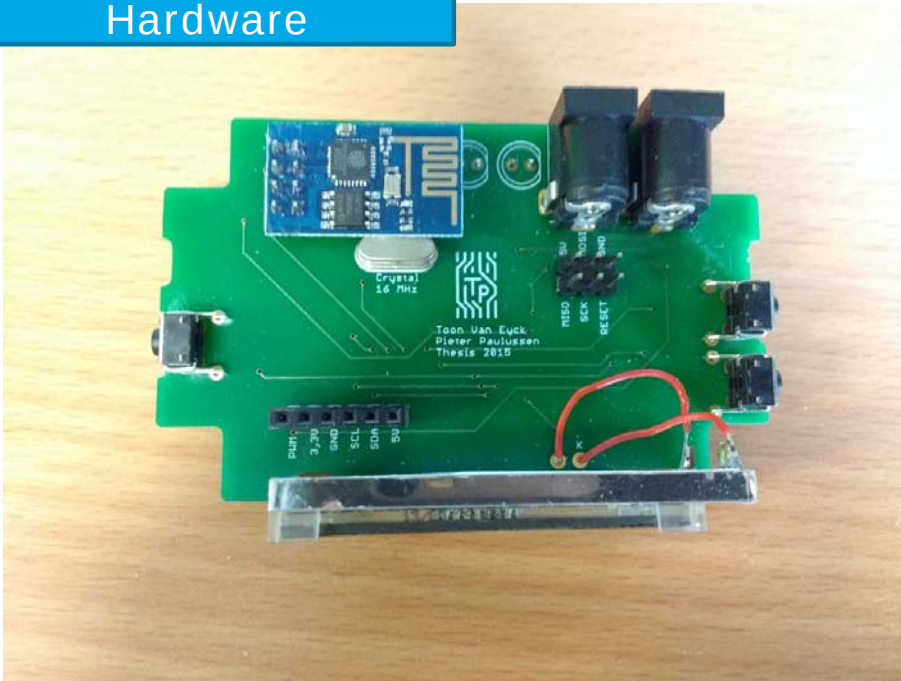


Bottom



EMBEDDED GREENHOUSE APPLICATION: ALGAE

Sensing module Hardware



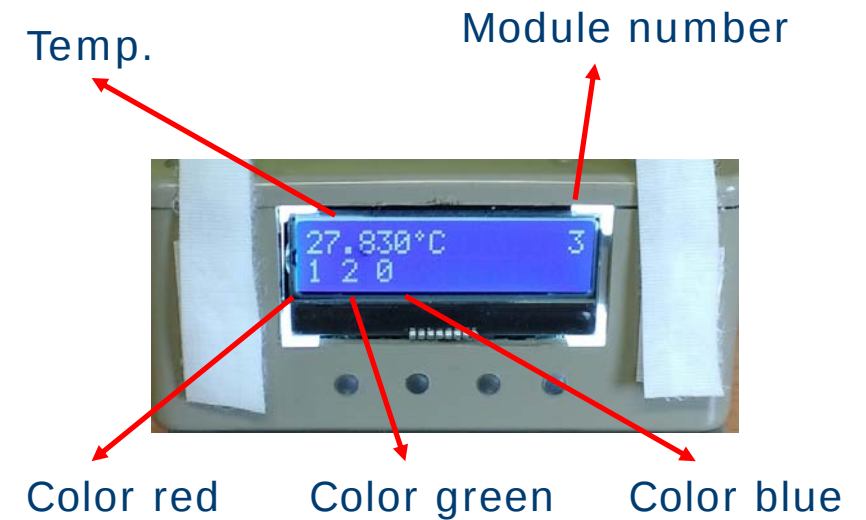
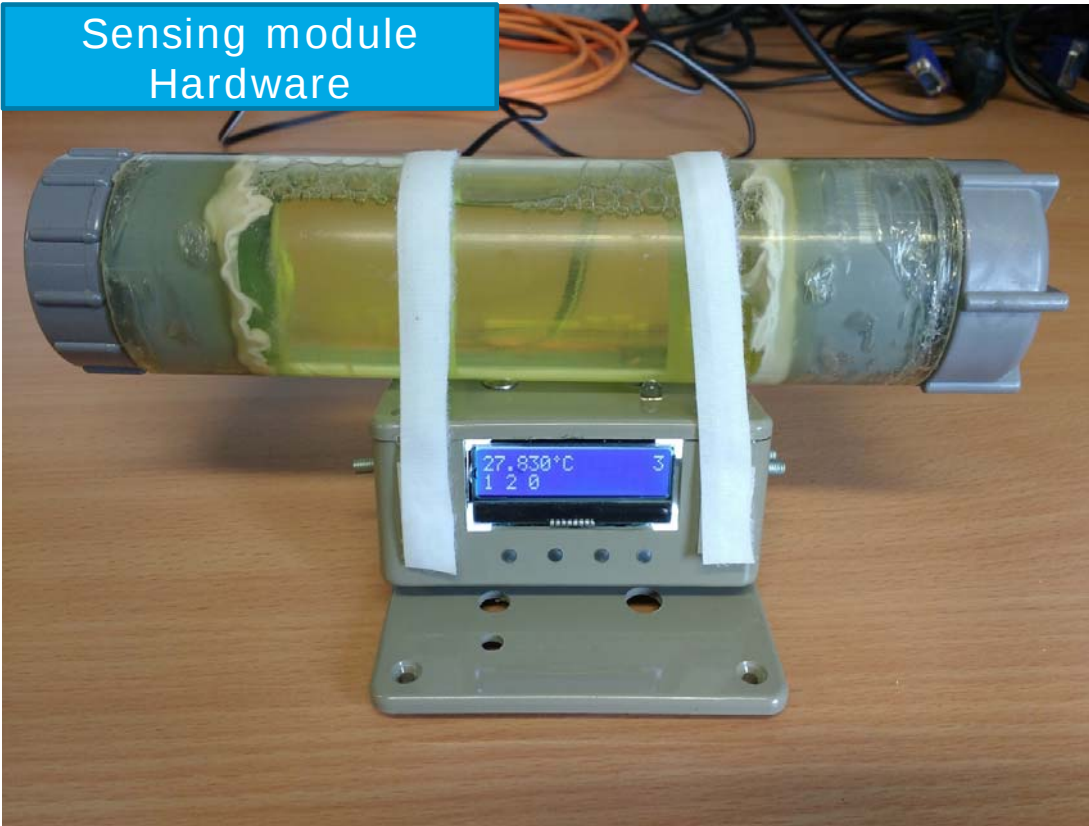
EMBEDDED GREENHOUSE APPLICATION: ALGAE

Sensing module Hardware



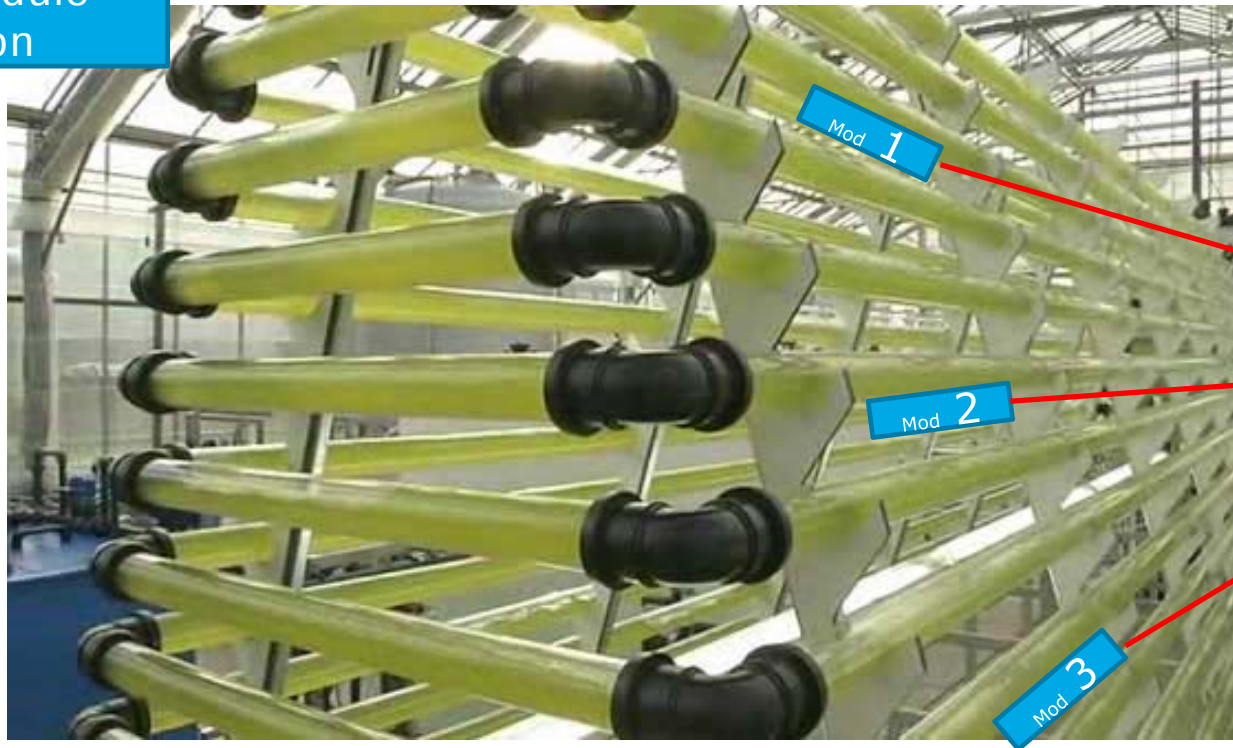
EMBEDDED GREENHOUSE APPLICATION: ALGAE

Sensing module
Hardware



EMBEDDED GREENHOUSE APPLICATION: ALGAE

Sensing module Realization



WiFi

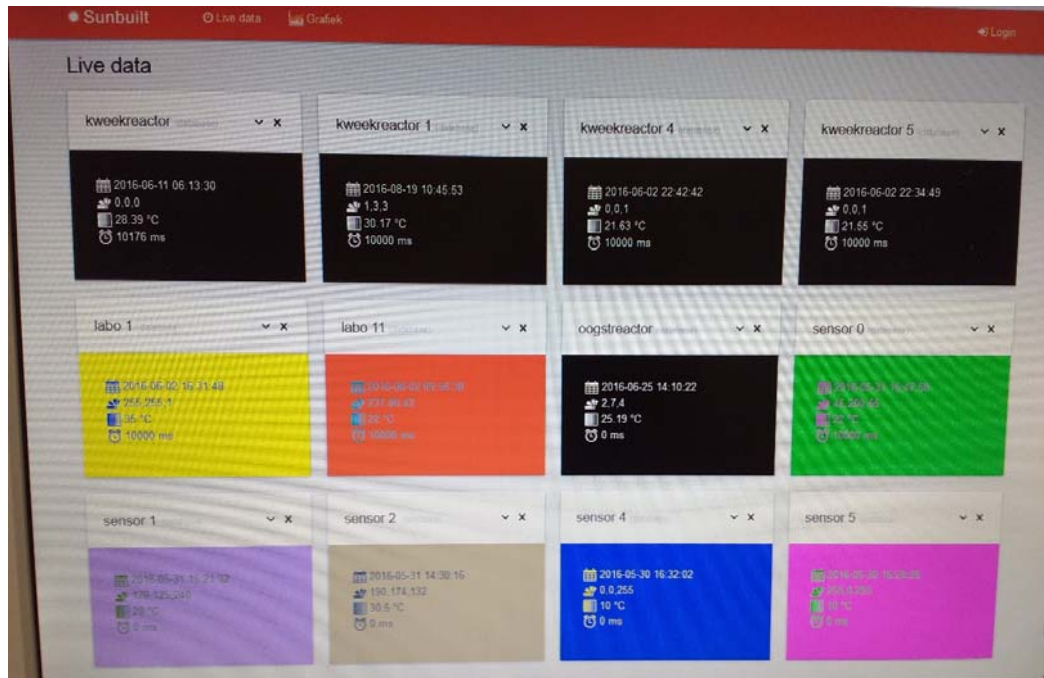
Rasp PI
Webserver
Database

Website



EMBEDDED GREENHOUSE APPLICATION: ALGAE

Rasp. Pi / Server
Web interface

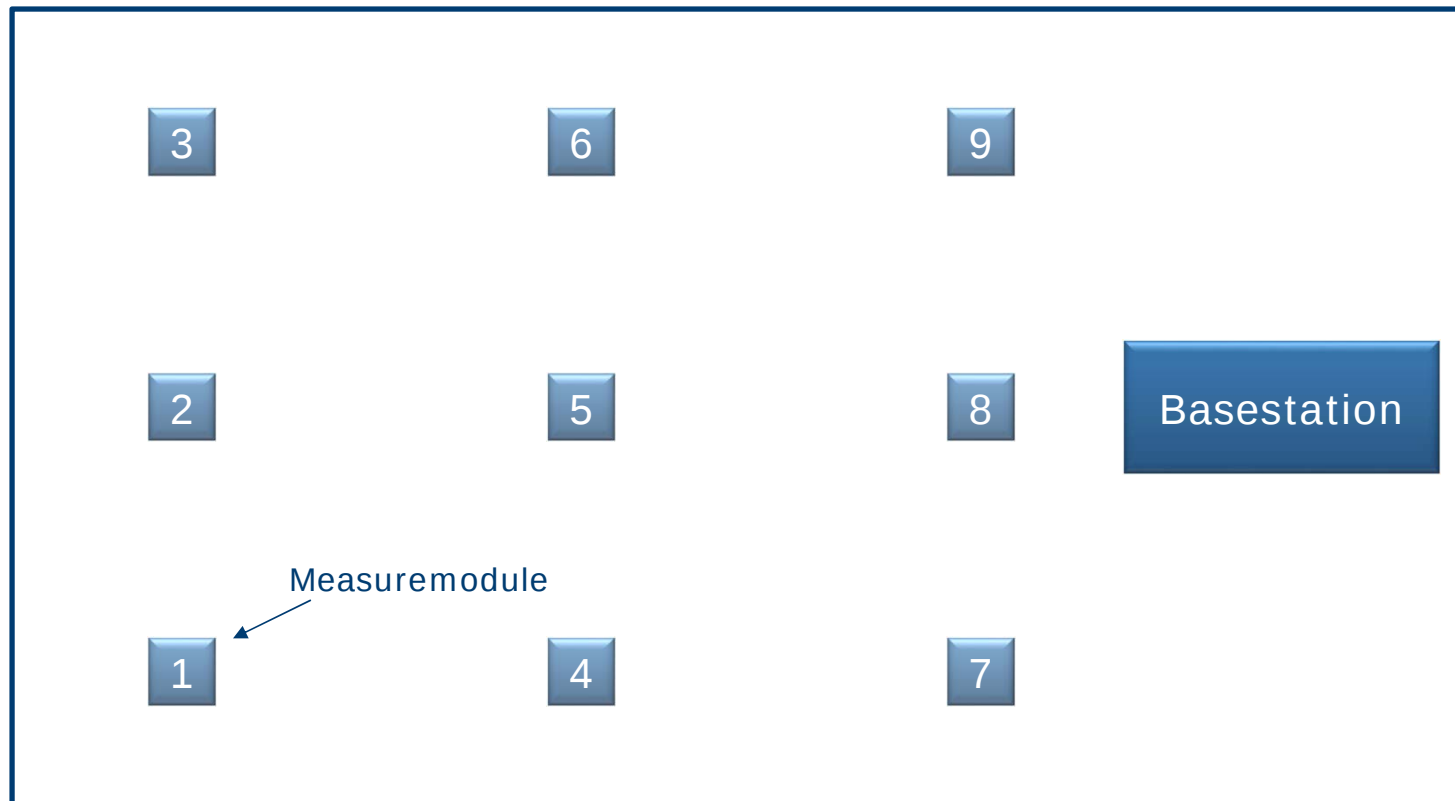


EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

- Purpose:
 - Get an idea of the temp and humidity in a greenhouse on different levels
 - Flexible (quickly use in another greenhouse)
 - Energy friendly
 - Easy to use

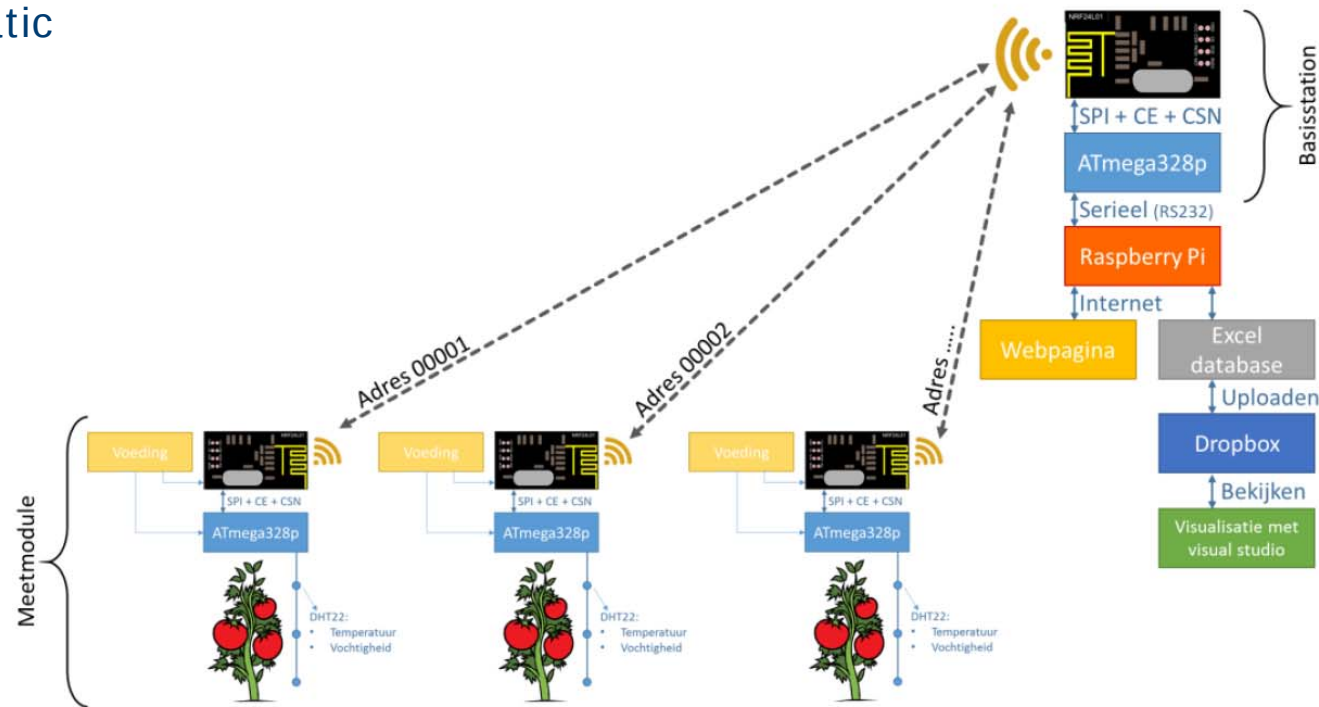
EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE





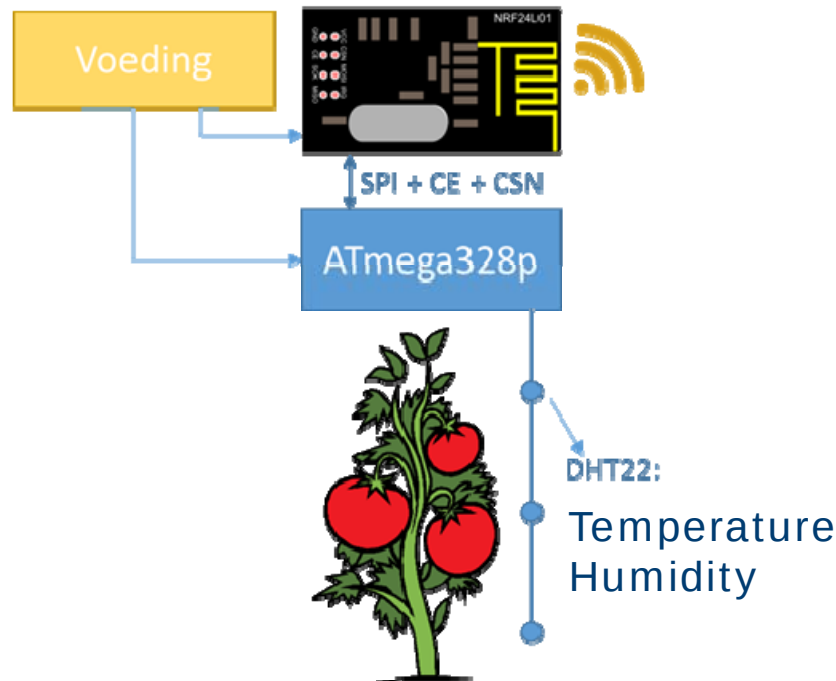
EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Schematic



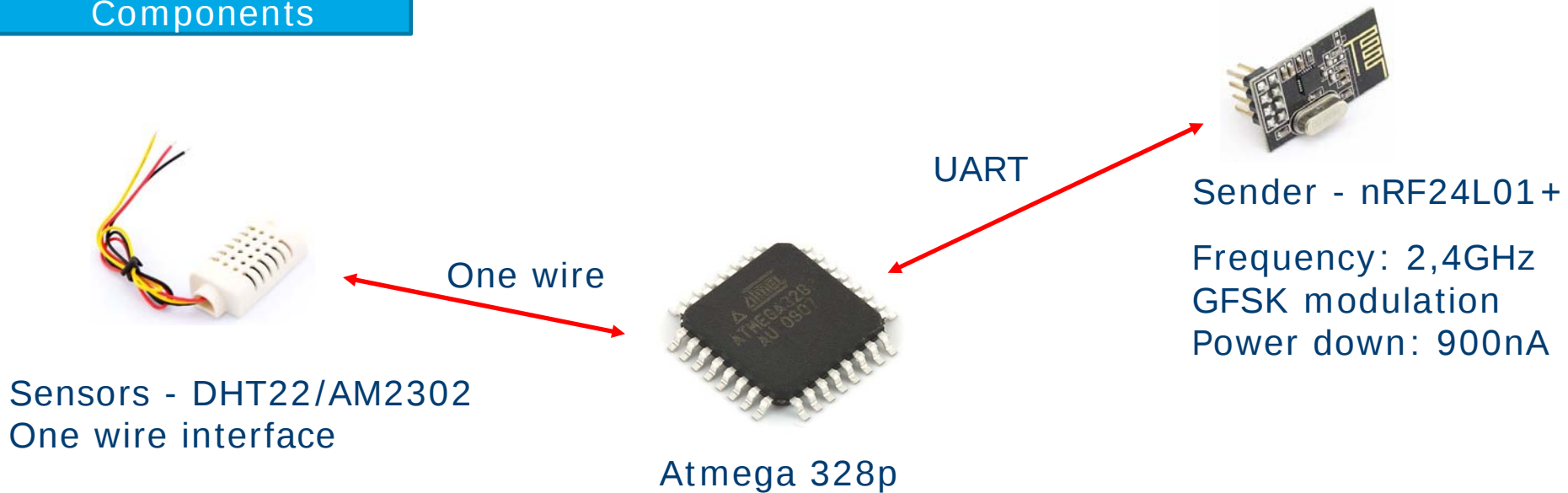
EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

- Sender
 - nRF24L01+
- Microcontroller
 - ATmega328p-PU
- Sensors
 - DHT22/AM2302
- Power supply
 - LiPo Rider Pro
 - MEF1S0503SPC



EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Sensing module Components



EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Power supply

LiPo Rider Pro

3W solarpanel
LiPo-battery 6600mAh
5V supply



MEF1S0503SPC (DC-DC convertor)

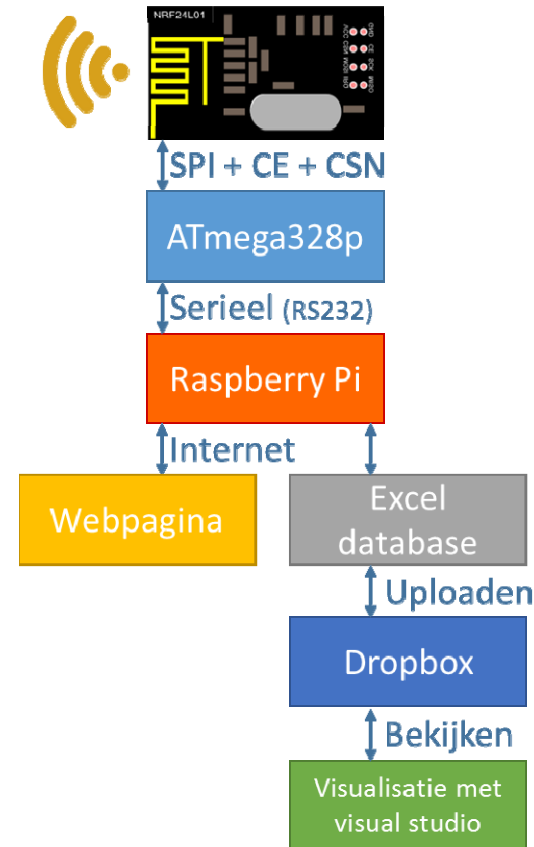
5V in
3,3V out
1W



EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Sensing module Base station

Sender
nRF24L01 + PA + LNA
Microcontroller
ATmega328p-PU
Server (Raspberry Pi)
Webpage
Database



EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Web interface

Set up your measurement

The screenshot shows a web browser window with the address bar displaying '192.168.137.6:8000/instelpagina.html'. The page title is 'Thomas More - Temperatuur meting serre'. The interface is divided into a left sidebar and a main content area. The sidebar contains links for 'Startpagina', 'Instellingen', 'Grafiek', and 'Tabel'. The main content area has a green background and is titled 'Instelpagina'. It contains two sections: 'Gekozen instellingen' (Selected settings) and 'Instelling' (Setting). Both sections show the same configuration: 'Type meting: 1: Temperatuur + vochtigheid 3 niveaus', 'Tijdsinterval: 10 min', 'Aantal pogingen: 35', 'Aantal rijen: 5', 'Aantal kolommen: 5', 'Aantal sensoren: 25', 'Start adres: 1', and 'Naam excel: Temp_Humi'.

3D temperatuurmeting

192.168.137.6:8000/instelpagina.html

Facebook Hotmail Toledo YouTube Translate Instrum... Stage School Twitter Nog te lezen Elektro...

THOMAS MORE Thomas More - Temperatuur meting serre

Meting is gestopt!

Startpagina

Instellingen

Grafiek

Tabel

Instelpagina

Gekozen instellingen

Type meting: 1: Temperatuur + vochtigheid 3 niveaus

Tijdsinterval: 10 min

Aantal pogingen: 35

Aantal rijen: 5

Aantal kolommen: 5

Aantal sensoren: 25

Start adres: 1

Naam excel: Temp_Humi

Instelling

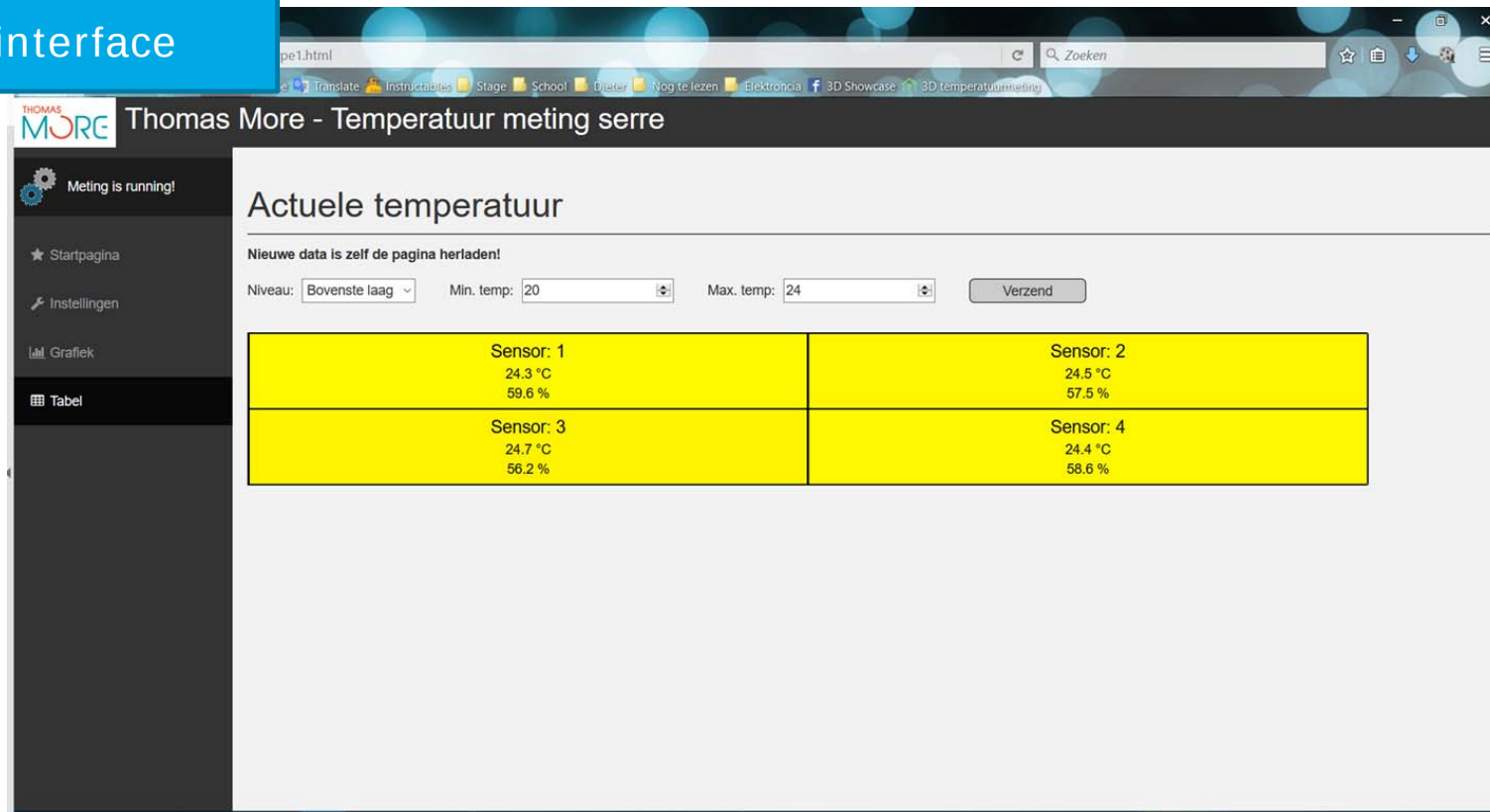
Type meting: 1: Temperatuur + vochtigheid 3 niveaus

Tijdsinterval: 5 min

Aantal pogingen: 35

EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Web interface



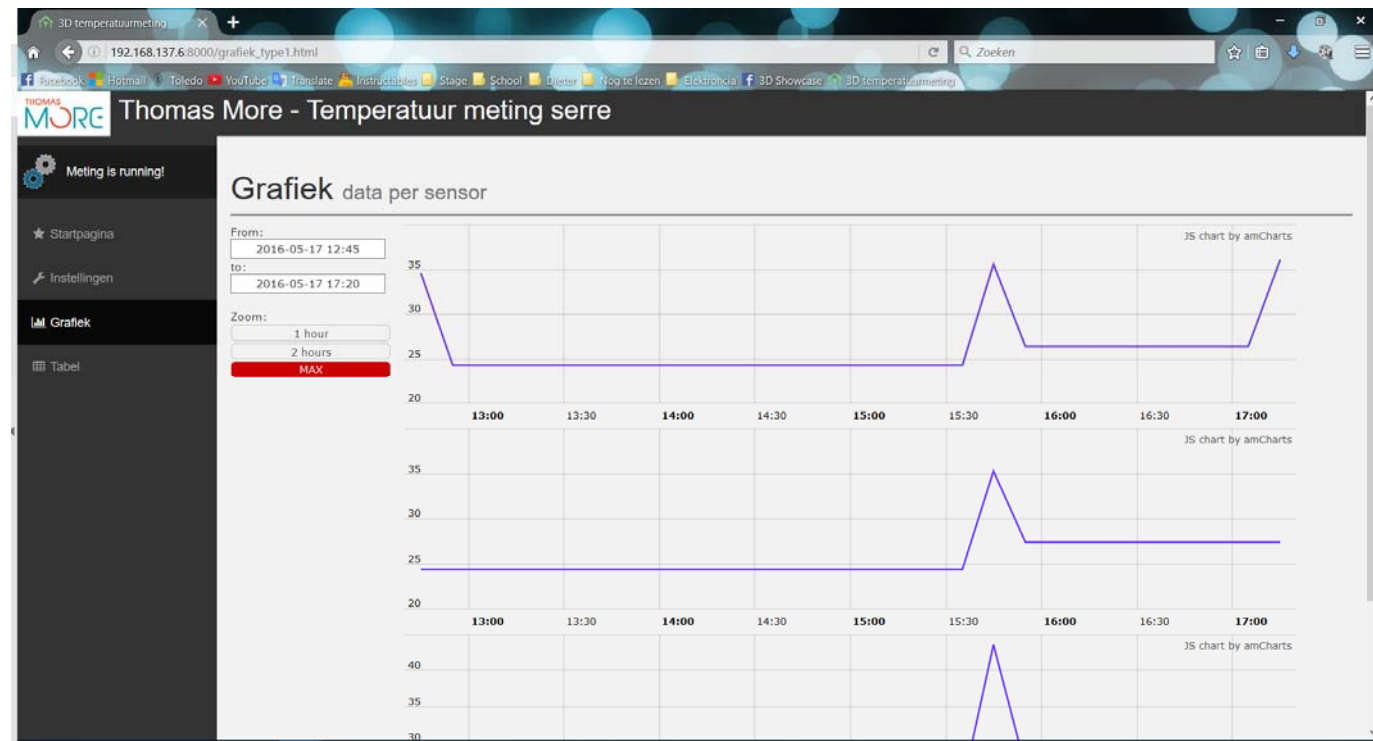
The screenshot shows a web browser window displaying the 'Thomas More - Temperatuur meting serre' application. The interface includes a sidebar with navigation options: 'Meting is running!', 'Startpagina', 'Instellingen', 'Grafiek', and 'Tabel'. The main content area is titled 'Actuele temperatuur' and features a message 'Nieuwe data is zelf de pagina herladen!'. Below this, there are input fields for 'Niveau' (set to 'Bovenste laag'), 'Min. temp' (set to 20), and 'Max. temp' (set to 24), along with a 'Verzend' button. A table displays real-time data for four sensors:

Sensor: 1 24.3 °C 59.6 %	Sensor: 2 24.5 °C 57.5 %
Sensor: 3 24.7 °C 56.2 %	Sensor: 4 24.4 °C 58.6 %

EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

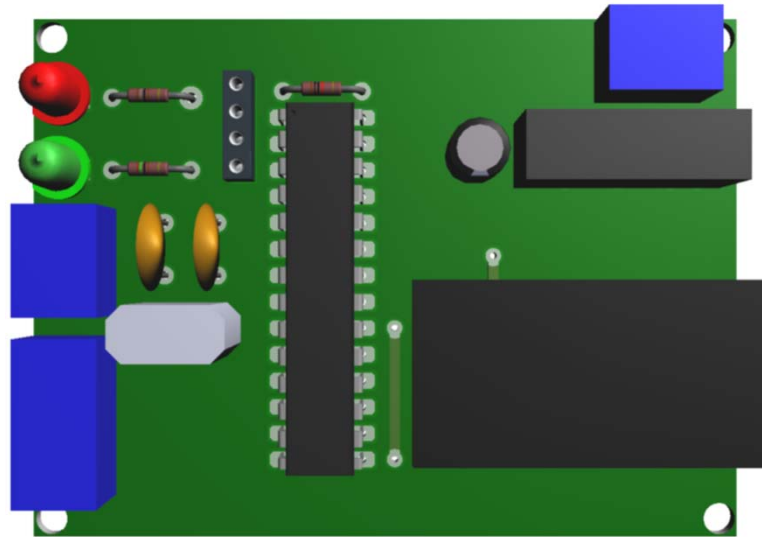
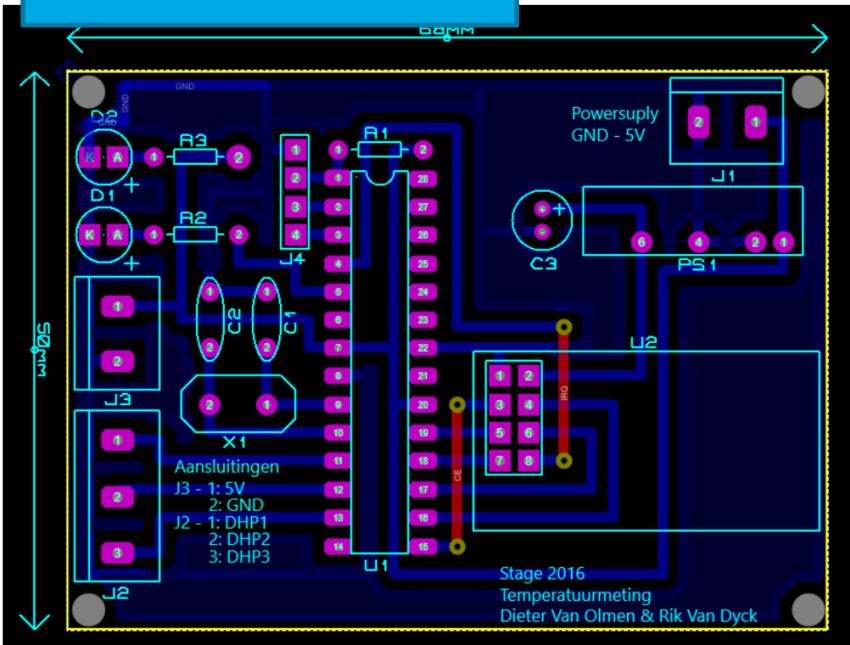
Web interface

Graphical way



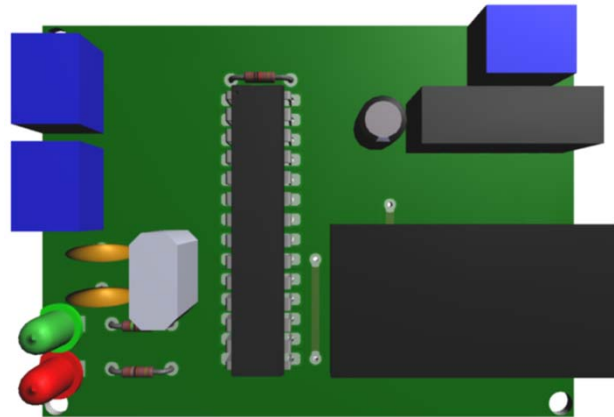
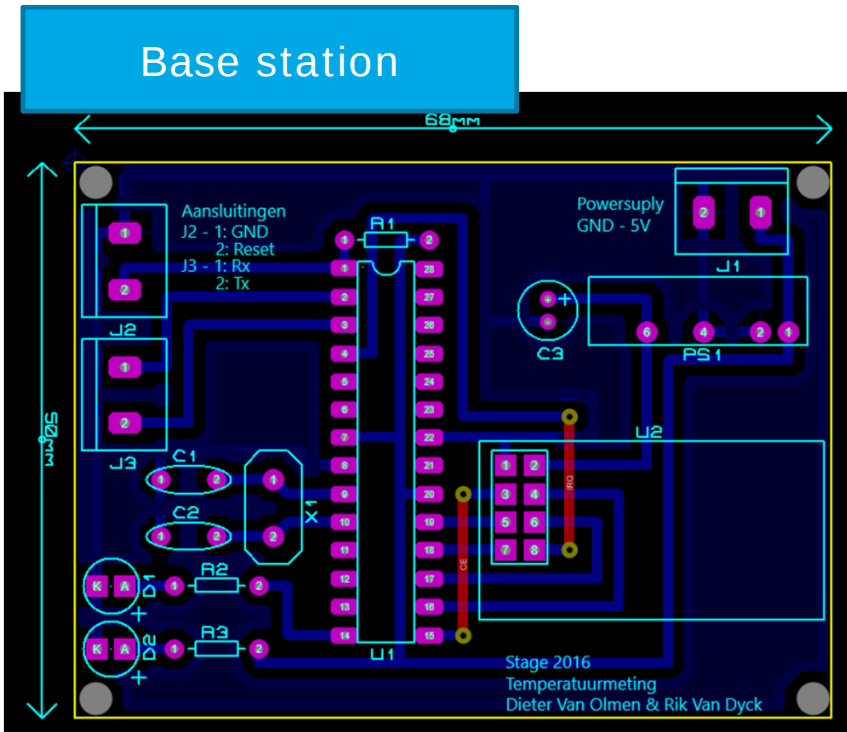
EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Sensing module



EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Base station



EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Realization



EMBEDDED GREENHOUSE APPLICATION: GREENHOUSE

Realization



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- Thank you for your attention.
 - Contact:
 - Peter.mertens@thomasmore.be