Hotraco Group

**SASG meeting**

# *"Climate of Things"*

Ger Schoeber - Mgr Innovation & Technology

February 5th, 2019

## Overview

- Introduction Hotraco Group

- Some figures regarding greenhouses and horticulture in NL
- Zooming in on Hotraco Horti, movie (1 min)

- Project – organic cultivation – BioVerbeek
- Wireless sensors, road to a robust & reliable system:
  - Requirements
  - **System and software solutions**

- Movie: ☺ customer! (3 min)

# Hotraco Group

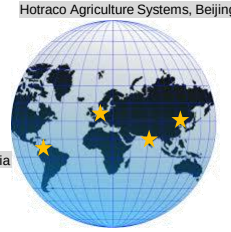
**Founded** : 1974

**Locations** : Hegelsom, Stationsstr 142 *(industrial, production, HR, IT, finance, mgt)*
Horst, Witveldweg 102 *(sales, logistics, training, service)*
Horst, Expeditiestr 4 *(R&D, purchasing, assembly)*

**Employees** : 250

**Turnover** : 50 M€

Hotraco Agriculture Systems, Beijing



Hotraco América Latina, Colombia

Hotraco Technologies, India



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**Hotraco Development Centre** | **Hotraco HQ & Production** | **Hotraco Sales & Logistics**

# Hotraco Group

**Intelligent Measurement & Control Platforms**

**Complete Control Panel Installations**

reliable and robust
customer specific system solutions
for Agri, Water and Industry



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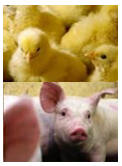
Hotraco Agri



Livestock climate & control equipment

Hotraco Horti

Greenhouse automation

Mooij Agro

Conditioned agro storage technology

HG Industrial

Control panels & high power distr. panels

HG Ulfima

Legionella bacteria filtration systems

Hotraco Development Centre

Hotraco Emware

R&D – Engineering – Production – Logistics – Training – Service







operation == "MIRROR_X":
irror_mod.use_x = True
irror_mod.use_y = False
irror_mod.use_z = False
operation == "MIRROR_Y"
irror_mod.use_x = False
irror_mod.use_y = True
irror_mod.use_z = False
operation == "MIRROR_Z
irror_mod.use_x = False
irror_mod.use_y = False
irror_mod.use_z = True
election at the end -a
_ob.select= 1
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ntext.scene.objects.a
Selected" + str(modi
ject is not

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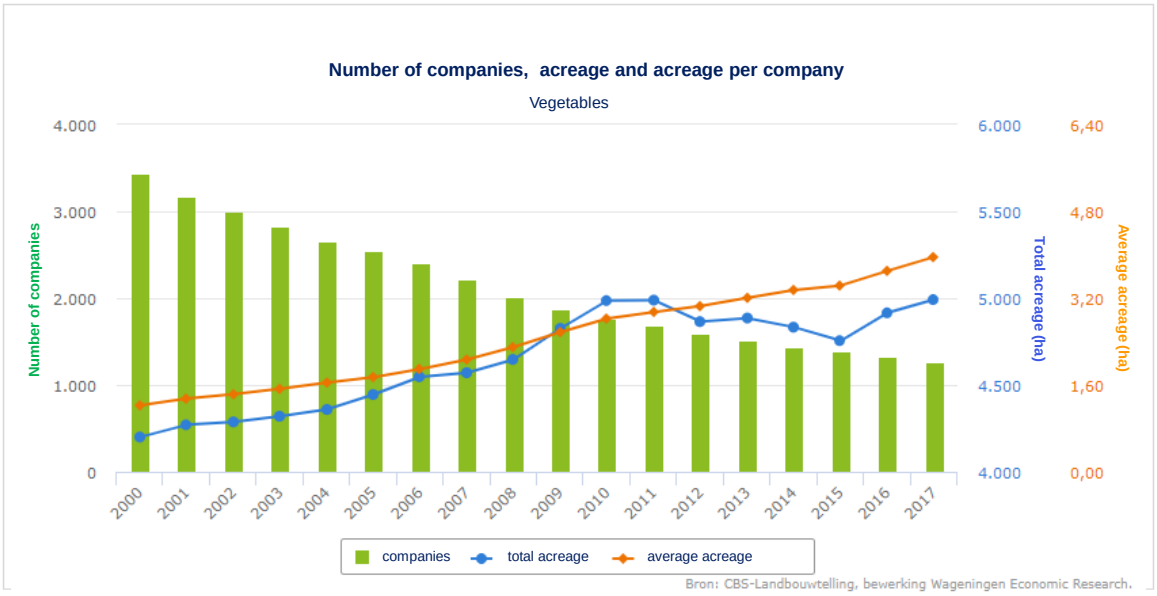


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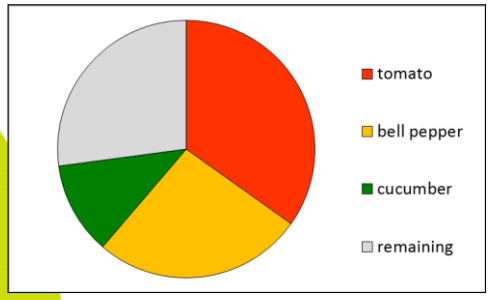
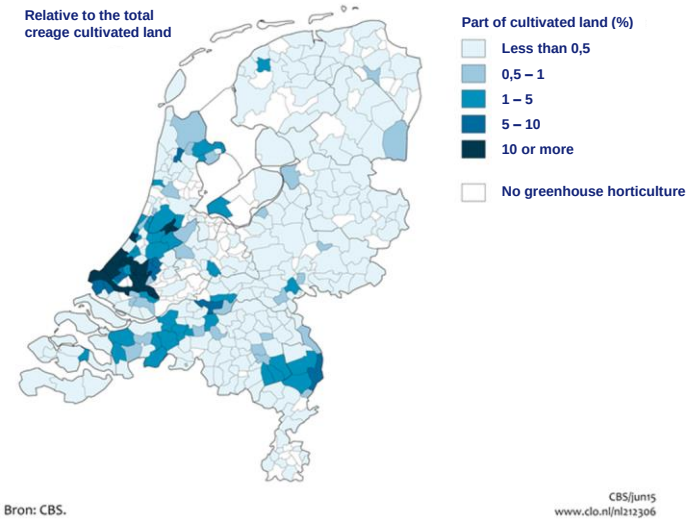



Acreage greenhouses per municipality, 2014

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## Greenhouse Automation

Climate condition
- Ventilation
- Screening
- Heating

Water management
- Irrigation

Inside:
- Temperature
- Humidity
- Carbon dioxide

Weather:
- Outside temperature/humidity
- Wind speed/direction
- Sun irradiation

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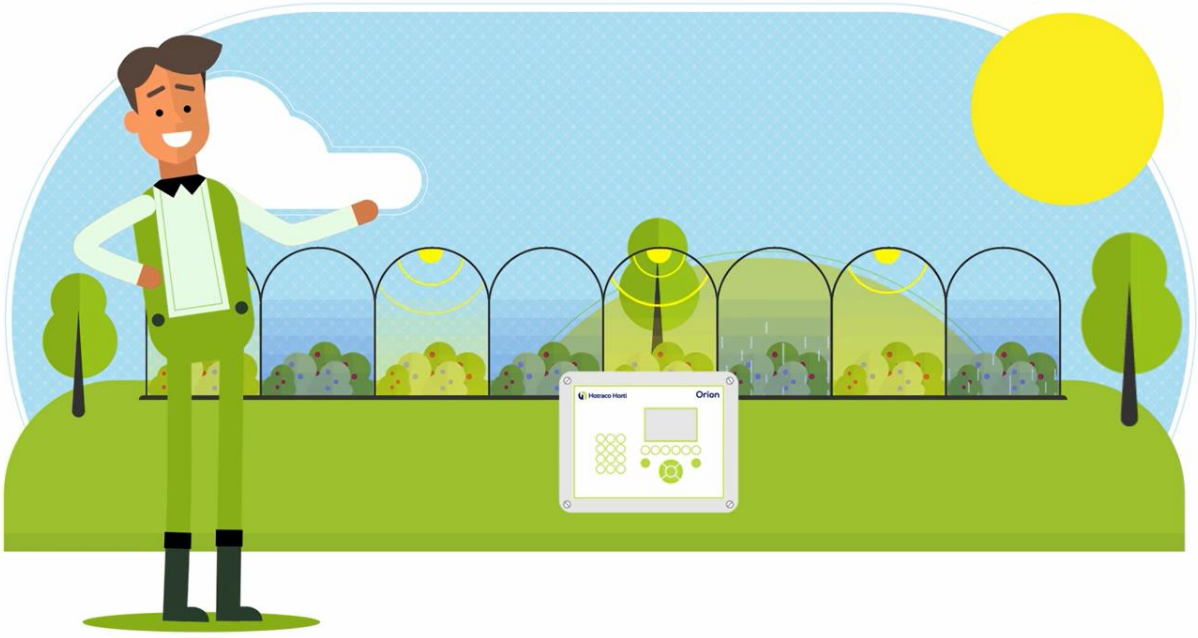


## Project: organically cultivated vegetables

- Healthy cultivation
- Low emission pesticides
- No GMO (genetic modified organisms)

- Early exhaustion of the soil
- Faster spreading diseases
- Production volume is 20% lower

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## Challenges, measures, impact

**Challenges**:

- Insects, viruses, fungi, bacteria

**Measures**:

- Biological iso chemical pesticides
- Biological manure iso fertilizer
- Steaming of soil (60 °C, 60 cm, 8 hours)
- Crop rotation
- Scouting!
- Own research

**Impact**:

- *Less effective*
- *More costly*
- *Intensive action*
- *Extra knowledge*
- *Extra work (30%)*

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## Project BioVerbeek

- 10 ha
- 4 greenhouses, 12 departments (respectively 4, 4, 2 and 2)
- Typically one sensor box (T/RH) per department






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## Wish: increase measuring granularity

Helps:

- Insight in climate homogeneity → crop homogeneity
- Reduce energy cost, controlling more optimal distribution of warmth
- Insight in humidity → spots for disease vulnerability / disease spreading

➢ *Wish to have about 25 sensors/ha iso of 1 sensor box/ha*

Solution:

- Wireless sensors
- Ease of installation, decrease of installation costs





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## Technical challenge

- Reliability
  - Measurement accuracy (at crop level);
  - Wireless communication (lots of steel, high humidity in plants/greenhouse)
- Robustness
  - Mechanically: mounting and housing;
  - UV irradiation;
  - low/high temperature (-20 °C - + 80 °C);
  - high humidity (up to 100%)
- Availability
  - 24/7 (battery powered), energy management



## Energy management requirements

- Energy availability:
  - Amount of energy (life time)
  - Steadiness of power level over time
  - Battery type (Alkaline, Lithium)
- Energy use:
  - Sensor element (reliable measurement)
  - Control electronics (processor, sleep modes)
  - RF communication (distance/resistance/reflection)
- Frequency:
  - Data granularity in time
- Installation and maintenance
  - Battery replacement frequency
  - Ease of replacing batteries
  - Network management
  - Battery costs
  - Battery lifetime > 1 year

# Solutions

- Zigbee
  - Standard protocol
  - 2.4 GHz: Worldwide, Data speed 250 kb/s, 16 channels
  - Low energy usage
  - Distance: 100m ( inline of sight)
- Sensirion T/RH sensor element
  - Reasonable accurate reading over required range

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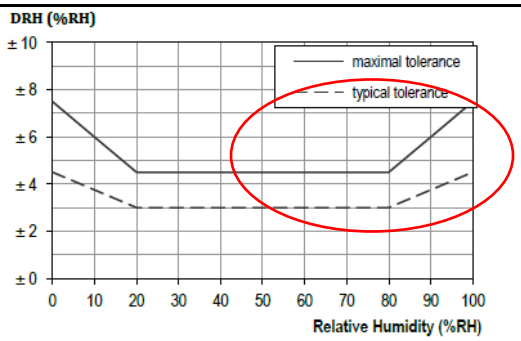



**Figure 2** Typical and maximal tolerance at 25°C for relative humidity. For extensive information see Users Guide, Sect. 1.2.

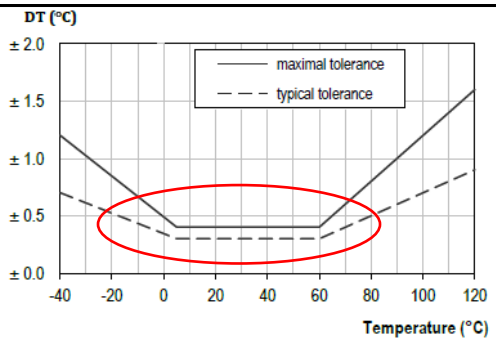


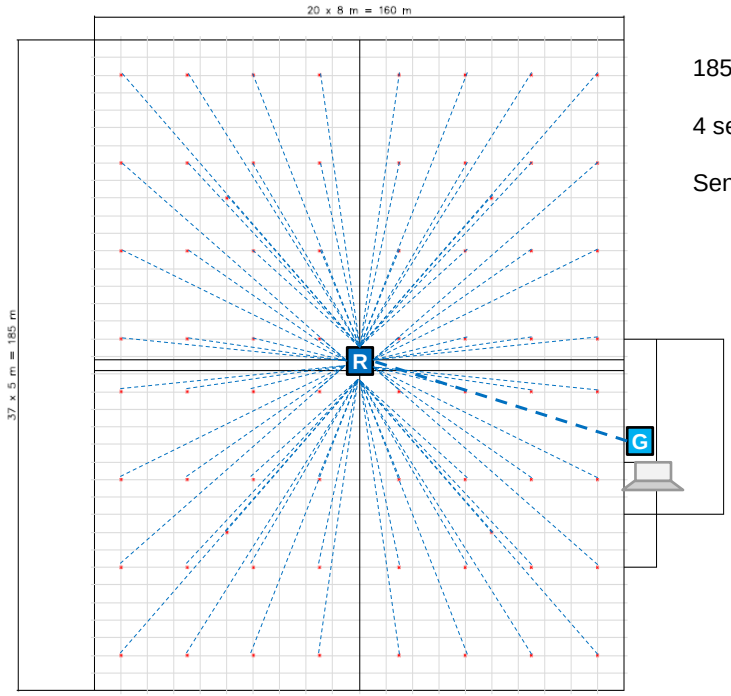

**Figure 3** Typical and maximal tolerance for temperature sensor in °C.

**Electrical Specification**

| Parameter | Condition | min | typ | max | Units |
|---|---|---|---|---|---|
| Supply Voltage, VDD | | 2.1 | 3.0 | 3.6 | V |
| Supply Current, IDD [6] | sleep mode | | 0.15 | 0.4 | µA |
| | measuring | 200 | 300 | 330 | µA |
| Power Dissipation [6] | sleep mode | | 0.5 | 1.2 | µW |
| | measuring | 0.6 | 0.9 | 1.0 | mW |
| | average 8bit | | 3.2 | | µW |
| Heater | VDD = 3.0 V | 5.5mW, ΔT = + 0.5-1.5°C | | | |
| Communication | digital 2-wire interface, I²C protocol | | | | |

**Packaging Information**

| Sensor Type | Packaging | Quantity | Order Number |
|---|---|---|---|
| SHT20 | Tape & Reel | 1500 | 1-100706-01 |
| | Tape & Reel | 5000 | 1-100704-01 |




185m x 160m = 3 ha

4 sections x 17 sensors = 68 sensors

Sensor – Router: max 120 m

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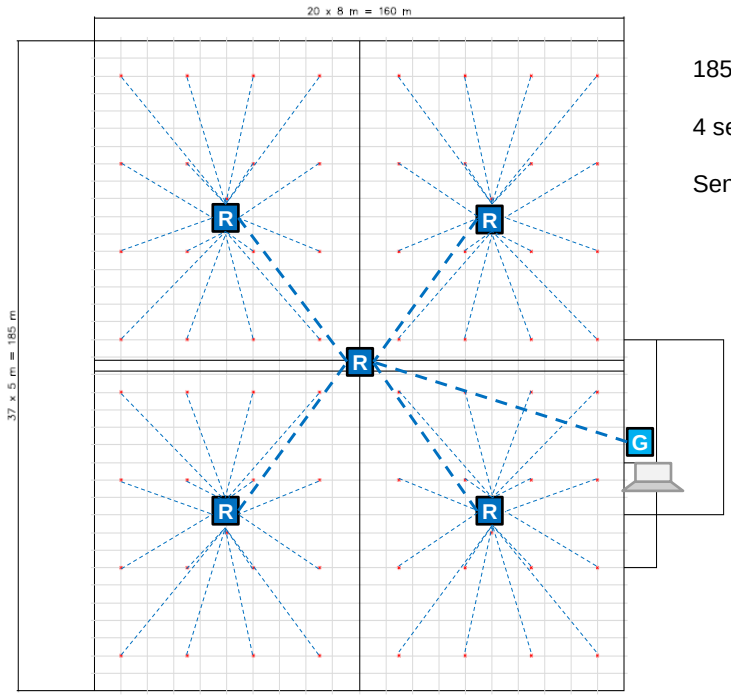


185m x 160m = 3 ha

4 sections x 17 sensors = 68 sensors

Sensor – Router: max 50m

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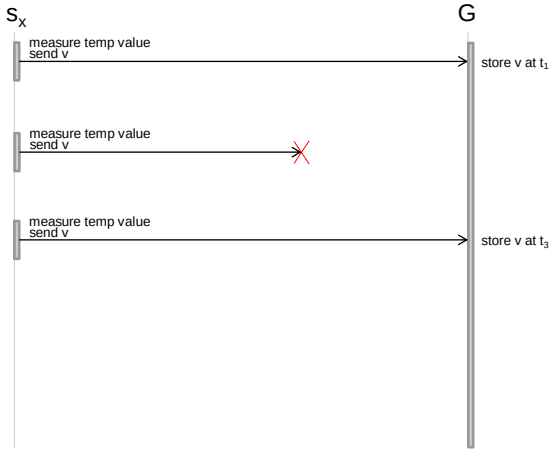
# Transmission failure: values are missed




DB

| t | $s_x$ | |
|---|---|---|
| $t_1$ | $v_{t_1}$ | |
| $t_2$ | ? | |
| $t_3$ | $v_{t_3}$ | |
| $t_4$ | | |
| $t_5$ | | |
| $t_6$ | | |
| $t_7$ | | |
| $t_8$ | | |
| $t_9$ | | |
| $t_{10}$ | | |
| $t_{11}$ | | |
| $t_{12}$ | | |
| $t_{13}$ | | |

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# Transmission failure: values are missed

Solution:

- Add acknowledge
- Resend upon transmission failure

Result:

- Retransmissions lead to extensive power usage.
- Batteries got drained early.

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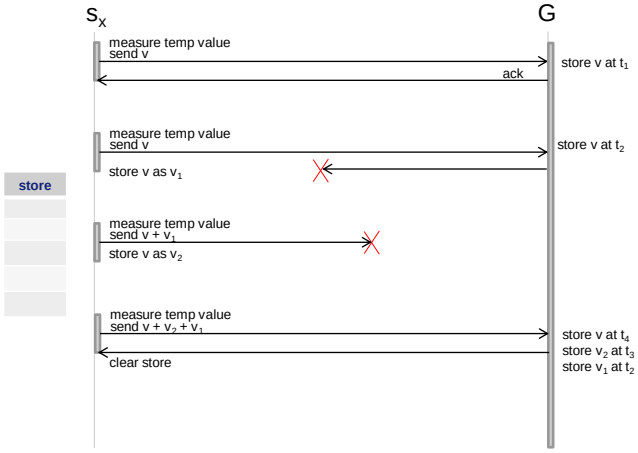
# Software architecture – 2 way protocol + backfilling




DB

| t | $S_x$ | |
|---|---|---|
| $t_1$ | $v_{t1}$ | |
| $t_2$ | $v_{t2}$ | rewritten |
| $t_3$ | $v_{t3}$ | backfilled |
| $t_4$ | $v_{t4}$ | |
| $t_5$ | | |
| $t_6$ | | |
| $t_7$ | | |
| $t_8$ | | |
| $t_9$ | | |
| $t_{10}$ | | |
| $t_{11}$ | | |
| $t_{12}$ | | |
| $t_{13}$ | | |

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# Software architecture – 2 way protocol, backfilling, time

Good results, as long as local storage did not overflow!
In case of overflow, backfilling was done at wrong positions in DB.
Night temperatures showed up in day-time!

Solution:

- Add timer in sensor
- Store local values with timestamp
- Transmit values with their time stamp
- Gateway broadcasts time at regular intervals

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# Lessons learned

- Humidity in crop and greenhouse are a great barrier for (2.4 GHz) RF communication! (Energy is absorbed by water).
- Steel construction in greenhouse can lead to awkward RF reflections.
- Cheap alkaline batteries have leakage problem at high temperatures.
- PCBs in greenhouse environment need to be coated against corrosion.
- Climatize sensors when replacing batteries to prevent condensation in sensor housing (battery clip corrosion).
- Regarding (non-)acceptable data loss – balancing power usage and availability:
  - Dependent on acceptable data loss, implement 2-way protocol.
  - Implement local data storage in sensor.
  - Implement local time management in sensor (including time mgt).

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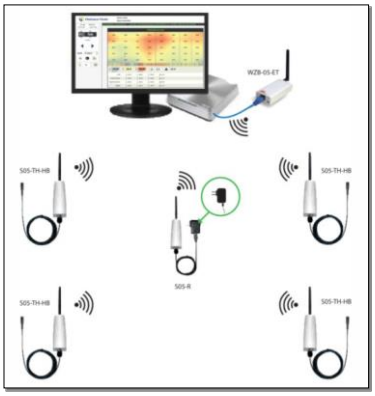

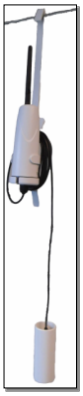

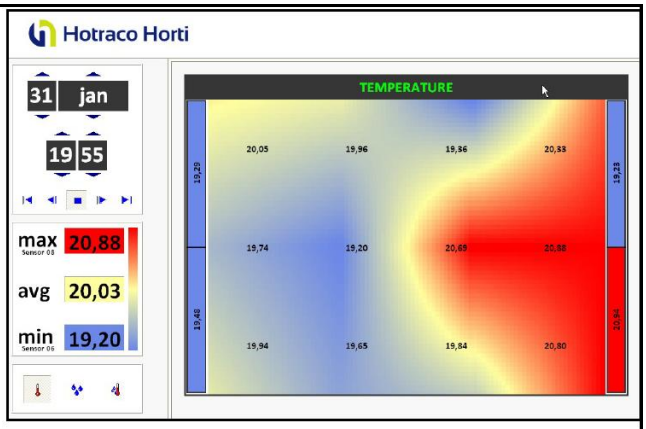


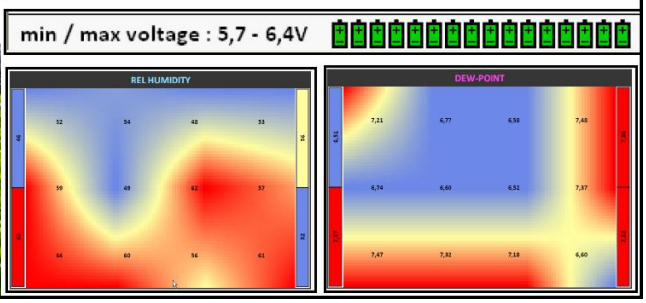


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***Thanks for your attention!***

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