Deploying low-cost, long-range IoT for rural and remote areas in Africa

ITU Telecom World 2018

workshop on

Challenges & Issues for Deploying IoT in Rural Africa

September 10th, Durban, South Africa

Prof. Congduc Pham

http://www.univ-pau.fr/~cpham

Université de Pau, France
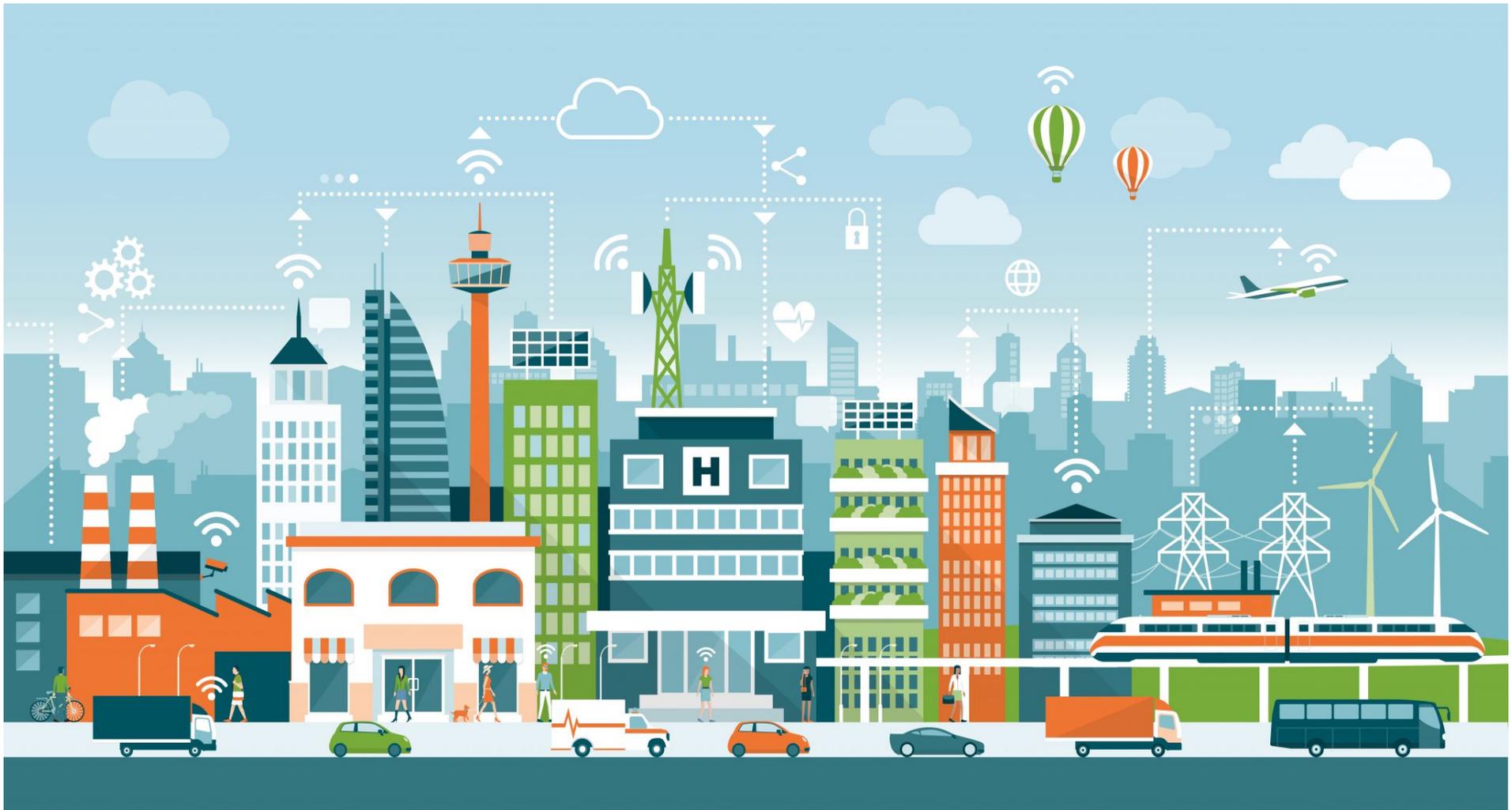
Needs, constraints, cost, design approach, control mechanism

Challenge: Bridging the digital divide

IoT becomes reality!
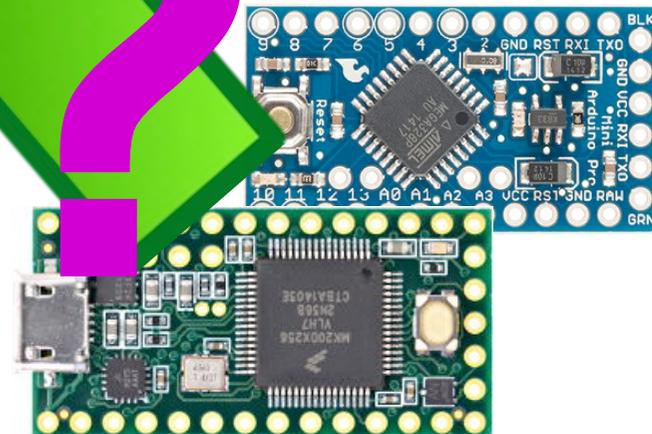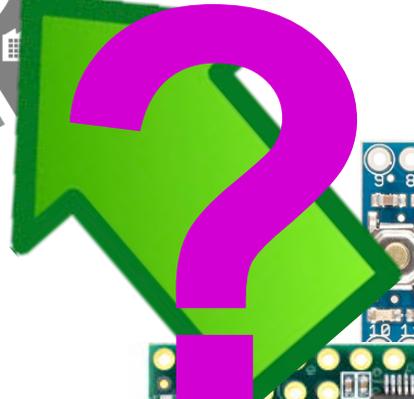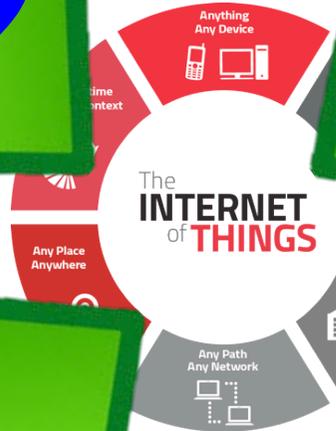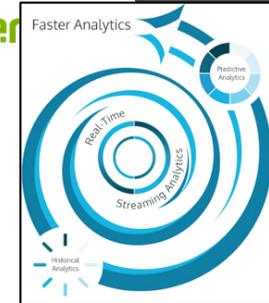
Ready-to-use templates

Moisture/
Temperature of
storage areas

10-15kms

Physical
sensor

Physical
sensor

Physical
sensor

Arduino Pro Mini @3.3V

Physical
sensor
mgmt

1.5€
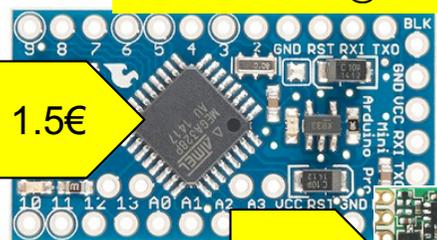
VERY
IMPORTANT

Activity
duty-cycle,
low power

VERY
IMPORTANT

4€

AES
encryption

Long-range
transmission

Logical
sensor
mgmt

setup

xxxxxx

measure

(encrypt)

transmit

sleep

wake-up

4
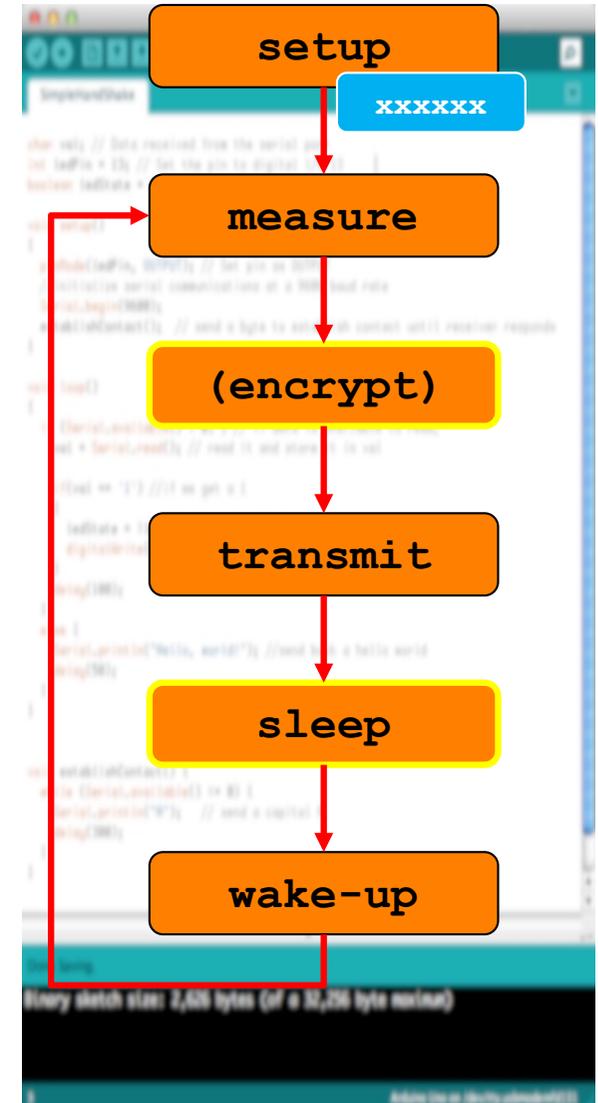
Running for several years!
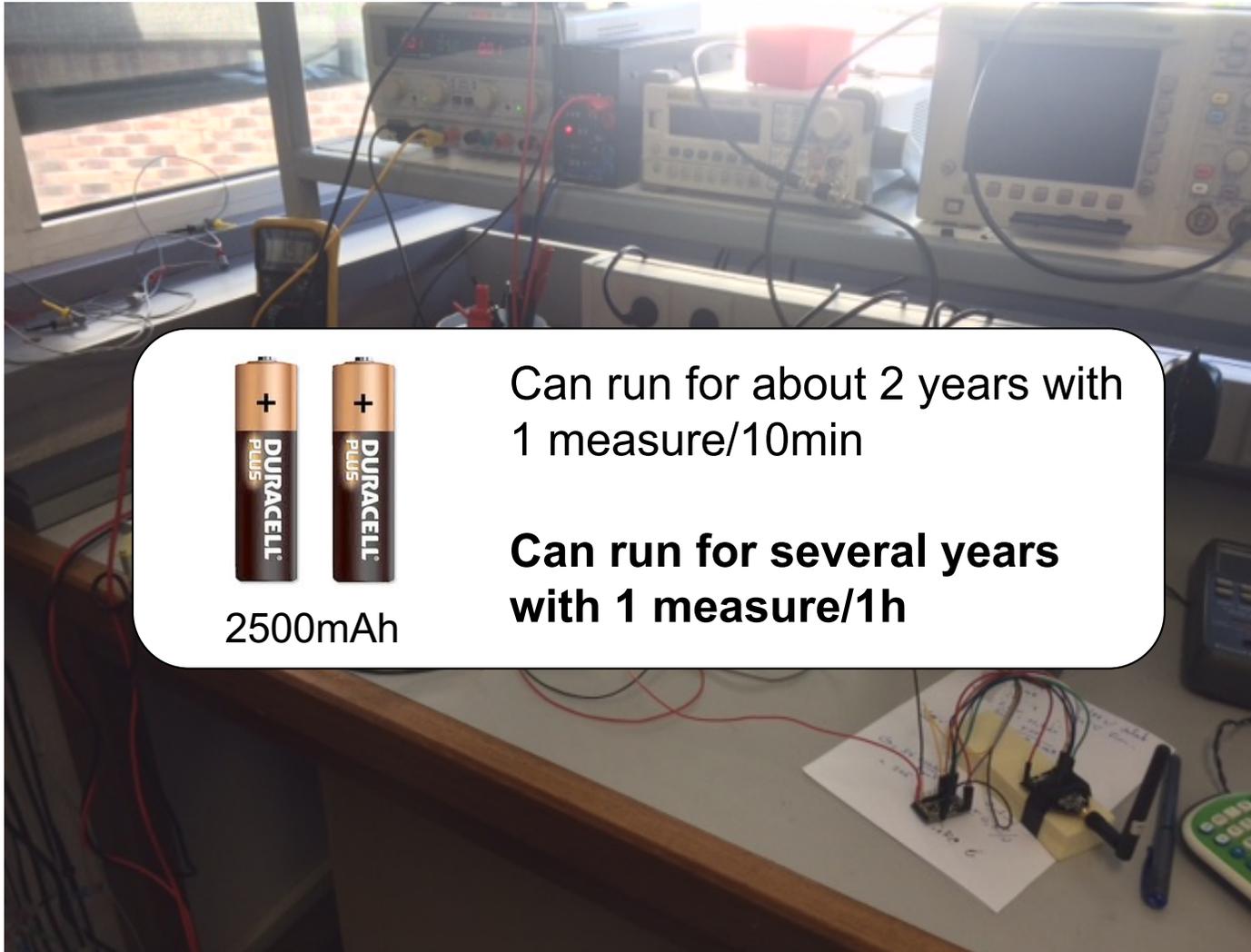
Can run for about 2 years with 1 measure/10min

Can run for several years with 1 measure/1h

2500mAh
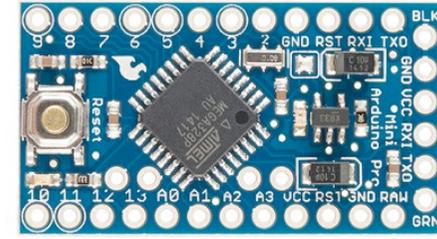
Wakes-up every 10min, take a measure (temp) and send to GW
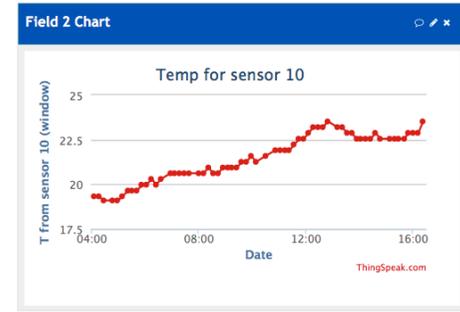
5µA in deep sleep mode, about 40mA when active and sending!

Full Do-It-Yourself approach

GND CS

VCC CLK MISO MOSI

LoRa™

OFF/ON Sensor 6 920.36
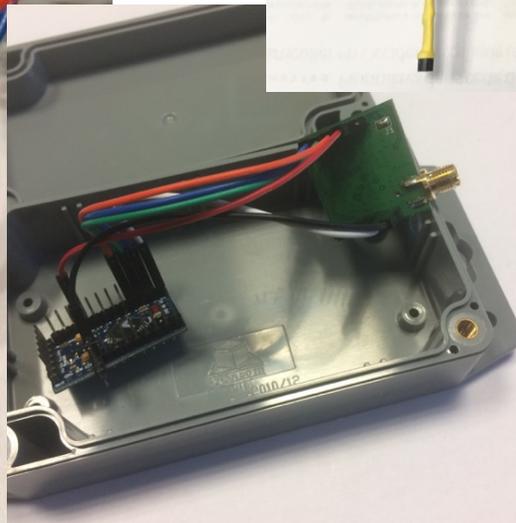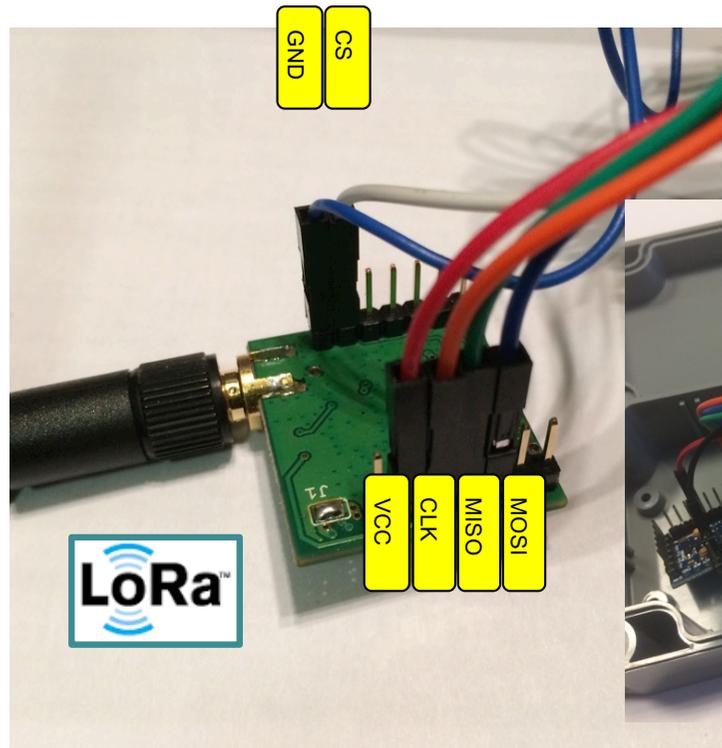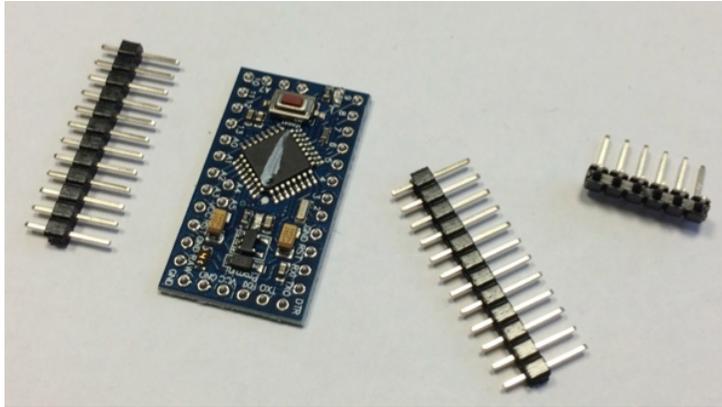
Still DIY but simple PCBs make it much easier for developers

From PCB to ready-to-use IoT kits

- 1 Arduino Pro Mini + FTDI breakout + 1 Arduino Nano
- RFM95 w/breakout + ¼ wave antenna
- 1 PCB w/integrated antenna (tunable)
- 0.96" OLED screen
- Jumpers+battery pack+case+breadboard
- Some sensors (LM35DZ, TMP36, DHT22, …)

TMP36

DHT22

Arduino Pro Mini @3.3V

Arduino Nano

RFM95

8
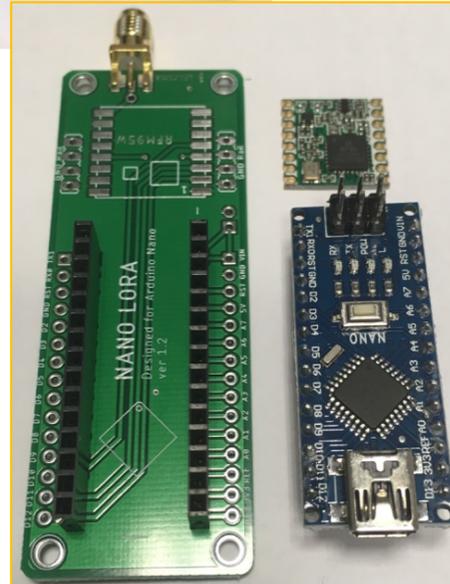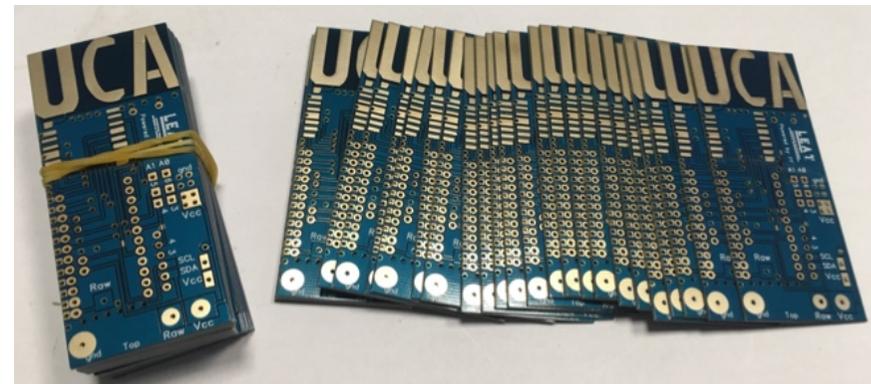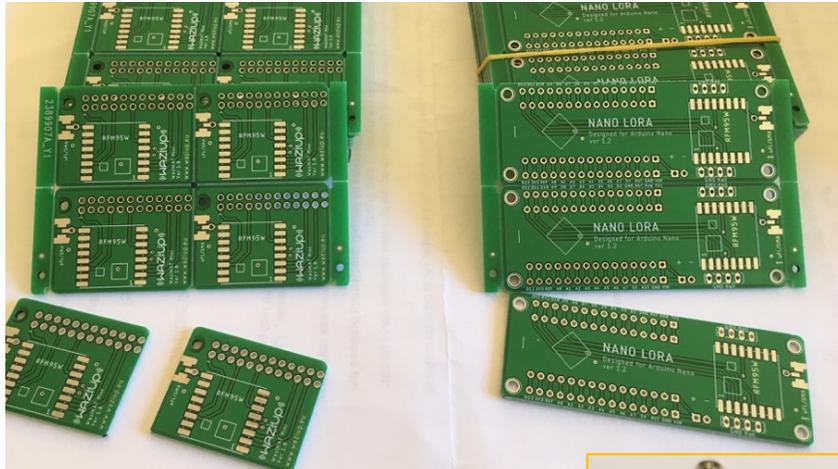
Using the IoT kit

❑ For both training (knowledge dissemination) and device integration (startup, entrepreneurs)
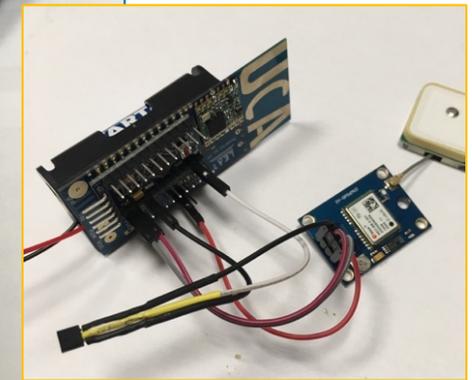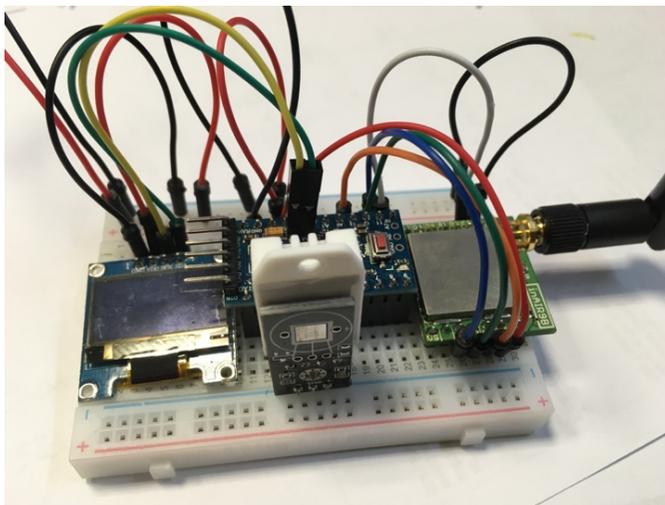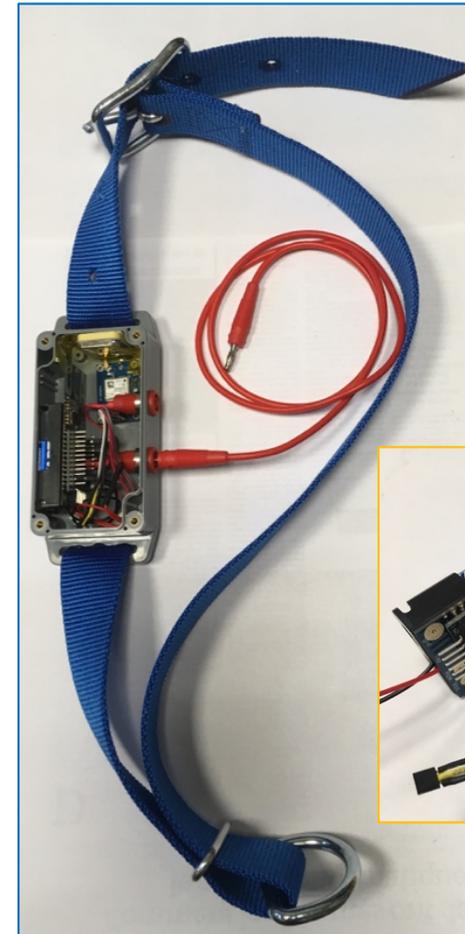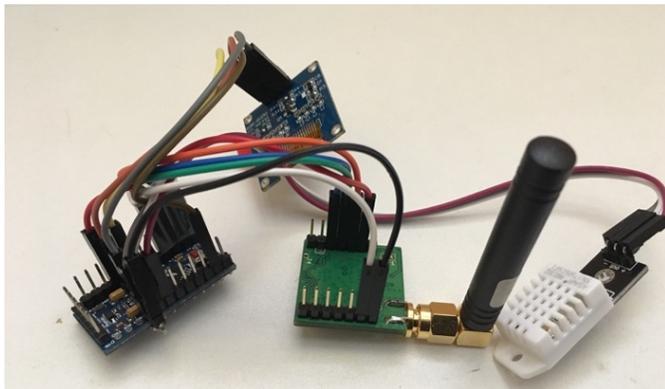
From generic to specific applications

GPS collar

Image sensors

Soil Moisture

Bin presented at Woelab

Waste Mngt

Photo from EGM

Buoy for water quality

Weather Station

Photo from Unparallel

10

LOW-COST COLLAR FOR CATTLE RUTLING: CIMEL FARM, SENEGAL

A web interface displays the position of the gateway those of the remote GPS devices

In Africa, the practice of animal husbandry has always been and still remain farmers' livelihood and incomes

Their main problem in this activity remain the cattle rustling and some families are put in dramatic situation after a theft (reported 2 billions CFA losses)

LOW-COST BUOY FOR FISH FARMING
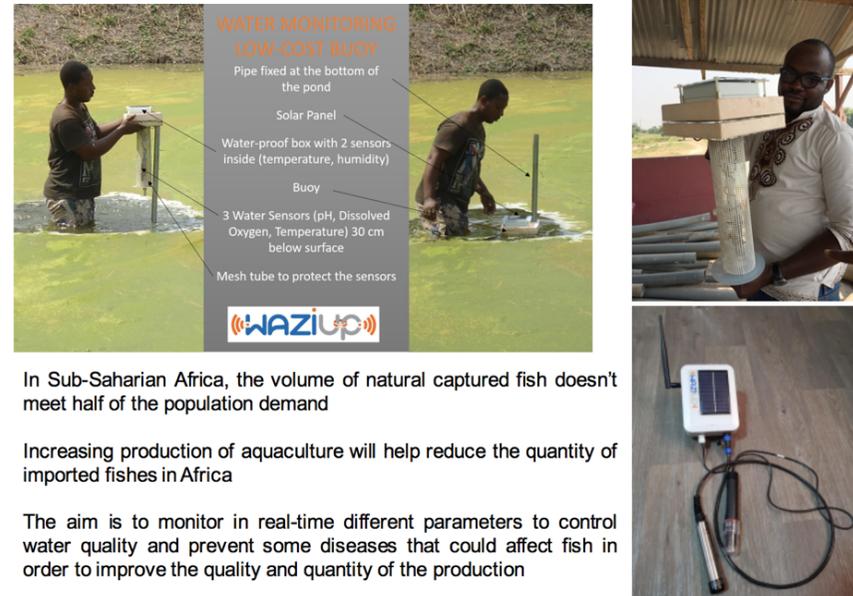
In Sub-Saharian Africa, the volume of natural captured fish doesn't meet half of the population demand

Increasing production of aquaculture will help reduce the quantity of imported fishes in Africa

The aim is to monitor in real-time different parameters to control water quality and prevent some diseases that could affect fish in order to improve the quality and quantity of the production

KUMAH FARM, GHANA

❑ The Kwame Nkrumah University of Science and Technology (KNUST)

❑ Located on the campus of the Kwame Nkrumah University of Science and Technology in Kumasi, Ghana.

❑ The farm comprises 30 constructed fish ponds, a farm house, a recirculating aquaculture system (RAS) laboratory and store houses.

SANAR FARM, SENEGAL

❑ Farm located at less than 2 km from UGB.

❑ One pond is dedicated for the Waziup application : 50x25m, average depth of 0.5 meters, populated by 4000 individuals of saltwater tilapia.

❑ The basin is irrigated via a water supply system fed by a river in proximity.

❑ The water in the pond is changed every 10 days

UBG farm, Senegal

Soil humidity sensor for agriculture
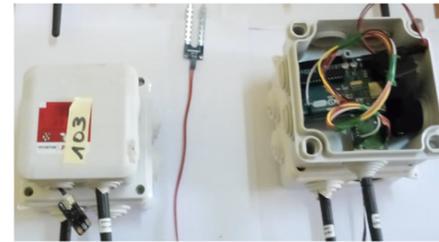
Monitoring soil moisture and other parameters to provide insightful recommendations and notifications to farmers, and advisors

Nasso site, Burkina Faso

Bananas field

Papayas solos field

Banana plant

Papaya tree

Urbannatic gardens, Togo

Open gateway
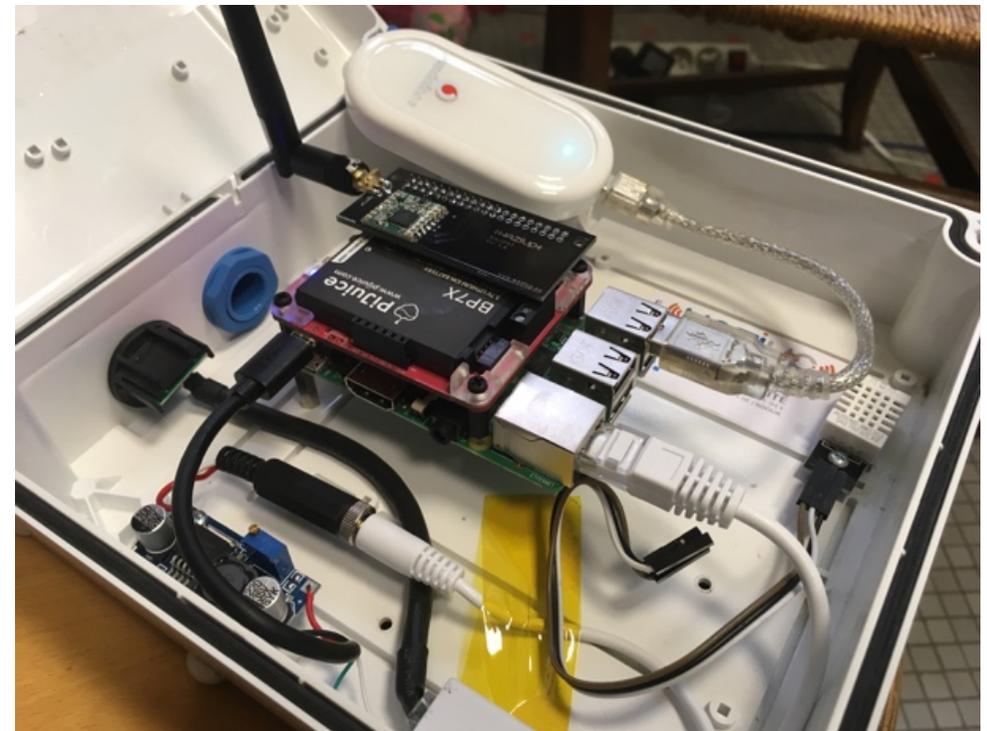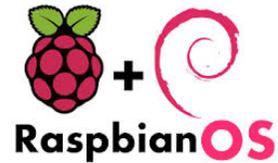
Raspberry PI: lots of libraries, lots of software, lots of hardware, lots of shields,…

LoRa Transceiver

2G SIM

Status LED GSM

UFL GSM antenna connector

PWR IN

UFL LoRa antenna connector

Status LED LoRa

Open, versatile gateway

Modular post-processing stage

RPI 3
WiFi
LoRa

RPI ZeroW
WiFi
LoRa+2G/3G shield

RPI 3
LoRa
WiFi
PoE
2G/3G dongle
DHT22 in-case sensor

radio bridge program → stdout → post processing → stdout

stdin

JSON

post-processing

Handle downlink data

AES encryption decryption ↔ LoRaWAN interoperability

Incoming data parsing block

Periodic task

Handle data from other radio interfaces

Monitor gateway temperature

user/app-specific

Cloud definition

cloud_script_1   cloud_script_2   -----   cloud_script_n   WAZIUP   local database

IoT in Africa usually means…

- ❑ … deploying IoT in very isolated areas…
- ❑ … where internet and electricity are not stable!

GW embedded applications: GPS for cattle localization – on-the-go
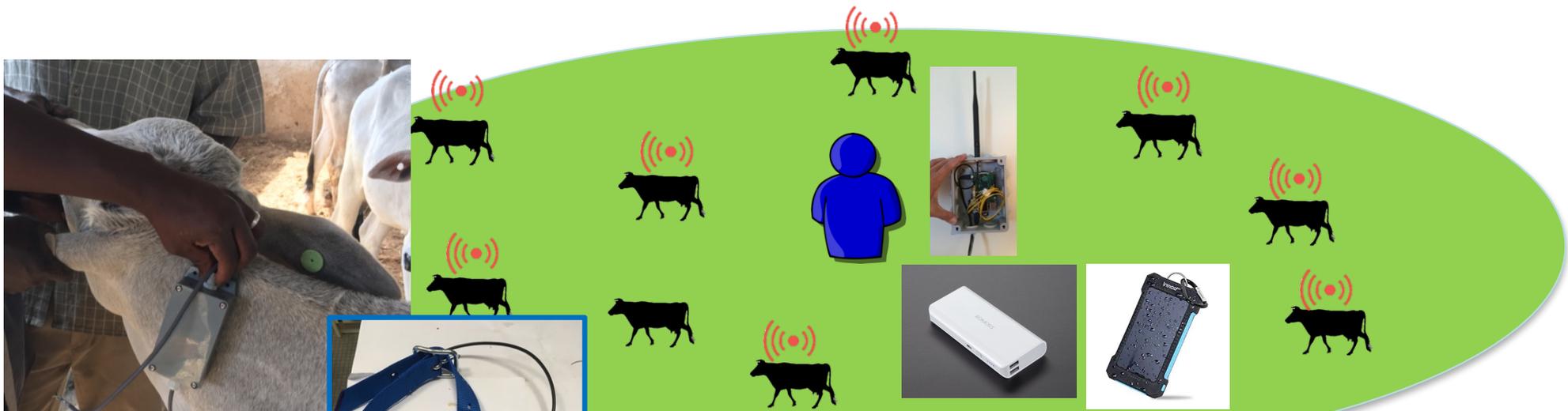
A web interface displays the position of the gateway and those of the remote GPS devices
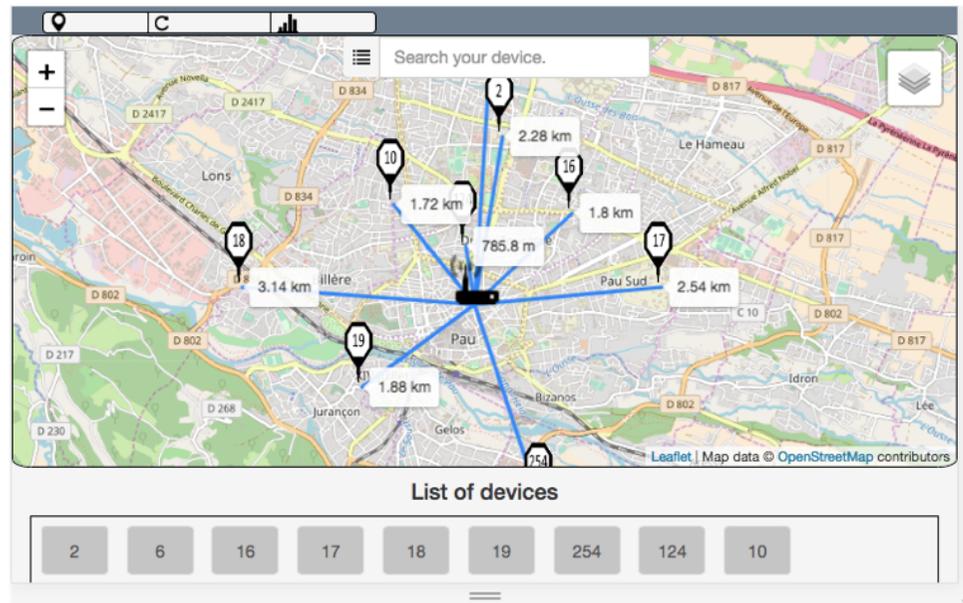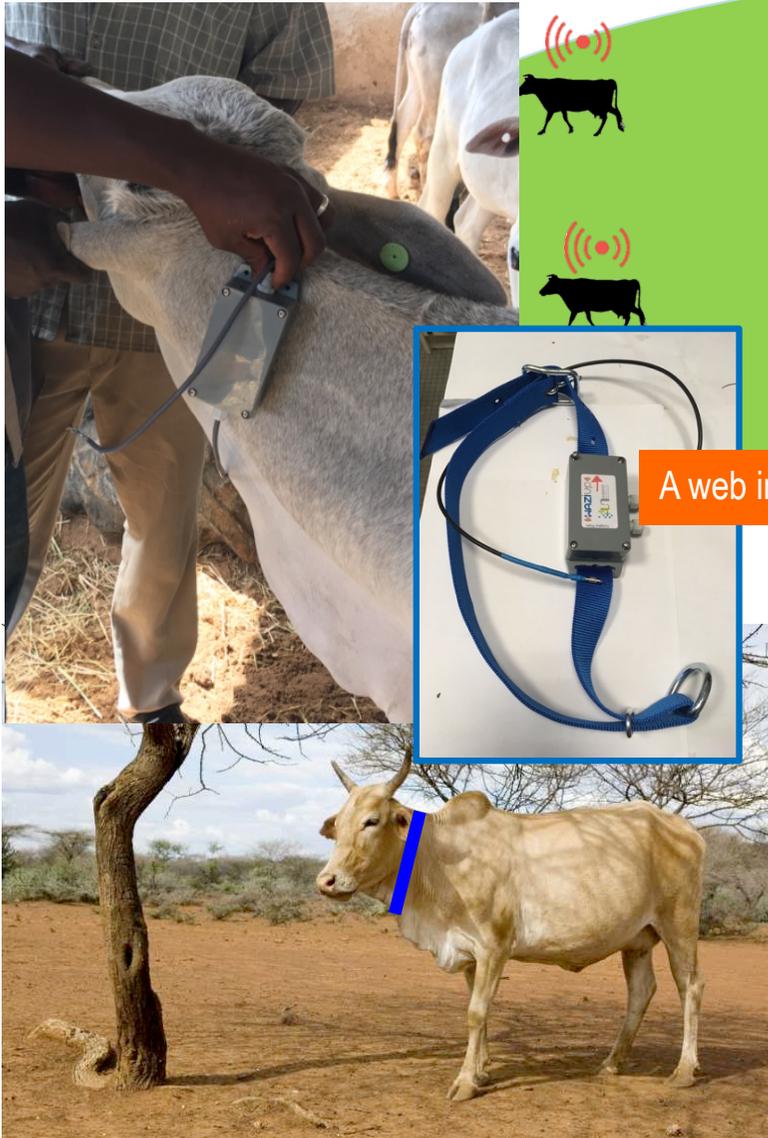
Cellular Internet and SMS

❑ Internet connection can be obtained from cellular networks

❑ Instead of uploading to clouds, the gateway can also send SMS to the end-user

❑ 1-hop connectivity to gateway is difficult to achieve in real-world, remote, rural scenarios

Typical Fresnel zones, depending on gateway's antenna height
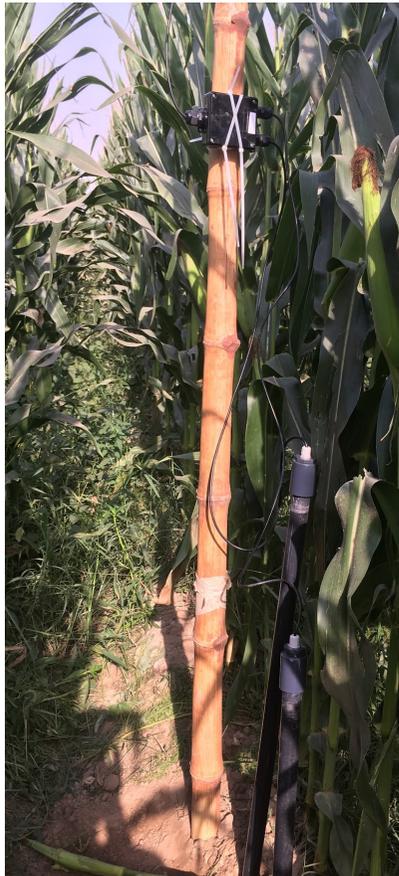
2-hop long-range approach

❑ **smart, transparent** relay node should be able to be inserted at anytime between end-devices and gateway to increase range

LoRa

LoRa

Relay-device

Gateway

End-device
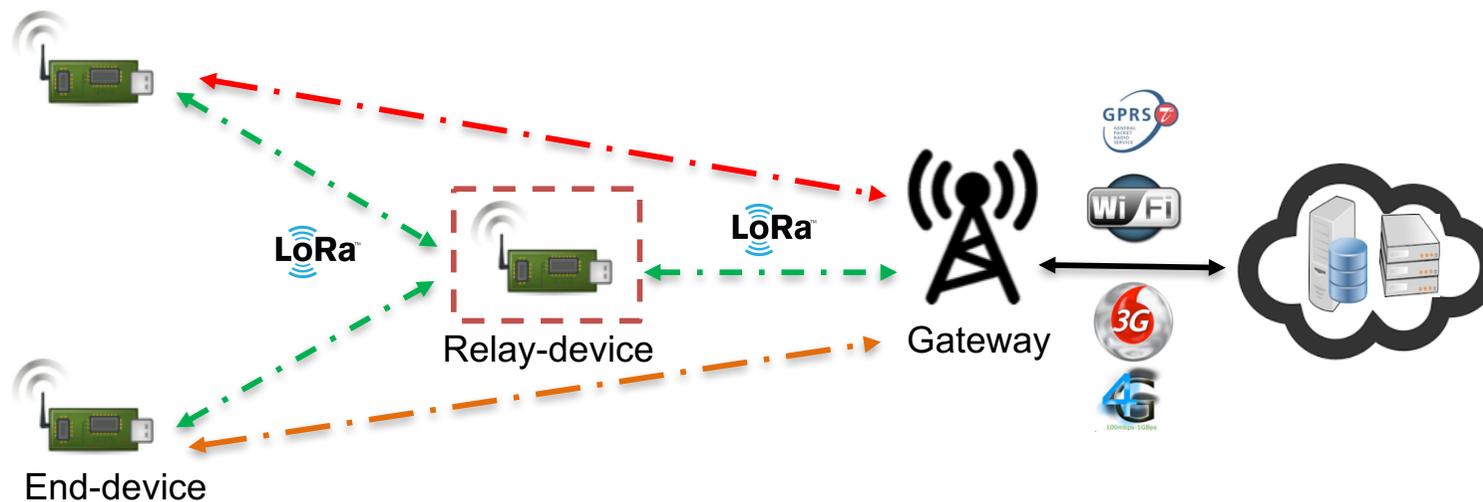
VISIT US AT THE SMART ABC PAVILION

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