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PRESS

WAZIHUB

Empowering Open Source and Affordable IoT Technologies in Africa

50 IoT applications in Africa

IoT technology for Africa

Waziup IoT deployments

IoT in Africa: future directions

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Title: WaziHub: Empowering Open Source and Affordable IoT Technologies in Africa

ISBN: 978-88-98989-66-9
Publisher: FBK Press, Trento, Italy
Published online in May 2021
Layout: Nuove Arti Grafiche - Trento
Infographik: Daniela Webber

Funded by the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 780229

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WAZIup
Affordable IoT Solutions for Africa
www.waziup.io

Foreword

Abdur Rahim

IoT, or 'Internet of Things', is an on-going revolution that is changing the way innovation is being made around the world. Startups, innovators and tech enthusiasts can now create their prototypes, with very little initial investment. Africa is taking part of this IoT movement, and great innovation opportunities lie there.

Furthermore, more and more startups and companies need to transition from the analog setup of operations to smart seamless operations. The COVID-19 situation has caused many innovators, developers, and companies to return to the drawing board. They need to quickly hack together solutions to continue operations and reach their customers efficiently. The ability to manage processes remotely with higher impact is what most organisations in various sectors scratch their heads about.

The Waziup (in Swahili "Open-Up") initiative funded by the European Commission under the H2020 framework program started in 2015 with a vision to offer fully open source Internet of things (IoT) technologies to African Tech Hubs, Start-ups and young communities (see page 11). The objective of this initiative is to provide a highly cost-effective and affordable IoT solution based on low power and long range LoRa communications. It is co-designed and co-developed by the African entrepreneurs in order to empower the social entrepreneurs and to foster the industrial IoT application.

The initiative expanded and enriched its activities under the H2020 WaziHub project. WaziHub's target is to support, at large-scale, innovative users and usage of the Waziup technologies, with a goal towards sustainability and Pan-African impact of the proposed solutions. Our aim is to enable the creation of Open IoT Hubs throughout Africa where IoT technology solutions can then be adapted to match local service needs.

Within WaziHub, we have organized more than 100 IoT training sessions, trained more than 1000 African young talents, distributed more than 200 IoT development kits, and supported 80+ startups to prototype their IoT solutions. WaziHub is building an African IoT open platform and ecosystem in collaboration with more than 10 TechHubs (see page 21).

I am thankful to the European Commission for funding this initiative and also our European and African partners, allowing us to realize this highly ambitious vision. I thank our Tech Hubs, startup communities for supporting us in realizing this vision. This initiative will transform into a new phase under European Commission funded project called HUBiquitous, in which we want to develop a joint European and African innovation ecosystem through the Tech Hubs network

The WAZIHUB applications

50 IoT applications in Africa

Africa is adopting more and more IoT applications and technologies, and looking out to adopt more. But which ones? To answer this question, we surveyed the IoT applications proposed by Africa-based startups and also collected IoT applications developed during several Africa-based IoT competitions and hackathons.

Agriculture

Agriculture is one of the main economic activities in Africa, making up most of the exportations. So, it is no surprise that most of the current IoT initiatives in Africa are about agriculture! IoT has the potential to revolutionize Agriculture in Africa, allowing a better control on processes, better crop yields, optimized water usage, and reduced wastes.

For instance, our startup AgriTechs in Tanzania (see page 30) proposes a Smart Hydroponic infrastructure for growing indoor vegetables, without needing to be physically present to monitor them every day.

Another of our startups, FarmSens, proposes a digital platform helping smallholder farmers who cannot afford soil testing services and extension services. In the following, we propose a list of 20 agriculture IoT applications currently being developed in Africa:

1. **Automatic Irrigation:** Improve the efficiency of irrigation in crop production.
2. **Livestock theft prevention:** Prevent theft of animals, e.g. with a collar for cattles with a GPS to keep track of lost/stolen animals.
3. **Livestock health:** Monitor the health such as stress, diseases of cows and pigs.
4. **Livestock pregnancy:** Monitor the pregnancy of animals, such as cows, and give early warnings.
5. **Automated feeding:** Automatic feeding systems for animals, managing storage, feeding time and food quantity.
6. **Grain storage:** Monitor the status and quantity of grain in storage.
7. **Hydroponics Monitoring:** Remote monitoring of hydroponic cultures for homeowners or small productions.
8. **Greenhouse monitoring:** Monitor the conditions in the greenhouse, such as temperature and humidity.
9. **Fish pond monitoring:** Monitor the health and status of the fish pond, such as temperature, pH, dissolved oxygen to optimize fish growth.
10. **Bio-fertilizer management:** Manage fertilizer deliveries. For example an automated agrovet-er machine can perform fast and safe delivery of bio-pesticide.
11. **Farming logistics:** Keep track of the operations in the farm, such as field work.
12. **Soil monitoring:** Monitor the health of the soils, such as pH and nutrients in order to optimize plant growth.
13. **Beehive:** Monitor the Beehive especially the temperature, humidity, weight of beehive.
14. **Mushroom farming:** Monitor the mushroom farm (internal temperature, humidity, weather condition).
15. **Pest monitoring:** Monitor the plants to detect pests and give recommendations how to prevent pests, such as cassava.
16. **Locust swarming prevention:** Detect the locust larvae in the ground, in order to prevent future swarming of locusts.
17. **Aquaponics:** Monitor aquaponic basins, where fish and plants are cultivated in symbiosis.
18. **Egg incubators:** The eggs incubators are fitted with IoT sensors to monitor the humidity and temperature during egg incubation.

19. **Dairy farming:** Monitor the quality and quantity of milk produced daily.
20. **Weather monitoring:** Monitor the atmosphere and contribute to improved weather predictions.

Smart cities

Cities in Sub-Saharan Africa are experiencing rapid population growth that comes up with well known negative effects: intense traffic, degraded air quality, deficient waste management… Authorities struggle to provide solutions and impose changes to citizens. IoT for smart cities in Africa proposes a different model: a "bottom-up" model, where the citizens are given the freedom to think up initiatives to create their own city.

As an example, our startup "Sterling Solutions" in Ghana (see the Magazine "WaziHub: Unlocking IoT Startups in Africa") proposes a Smart Bin that helps educate citizens about waste collection.

In the following list, we show some of the main IoT applications and initiatives currently being developed in cities around Africa:

21. **Smart Parking:** Detect free parking spots and guide the driver to them. Help the driver in the parking manouver.
22. **Water management:** Monitor city water quality, leak prevention and detection, drought prevention.
23. **Home security:** Detect and prevent intrusions in houses.
24. **Appliance monitoring:** Monitor the energetic performance of home appliances.
25. **Smart energy meters:** Monitor the household energy consumption, smart billing and pay as you go.
26. **Septic tanks:** Brown water level monitoring in the septic tank, alerts.
27. **Traffic monitoring:** Monitor the city traffic for analysing traffic patterns and give recommendations to optimize traffic.
28. **Air quality:** Monitoring the quality of air in order to give alerts and advices.
29. **Road accidents:** Contribute to the prevention of road accidents, such as a vehicular alcohol detection system.
30. **Waste management:** Optimize waste collection, transport and processing, for example Smart Bins able to alert the user when they are full.
31. **Smart street lighting:** Optimize street lighting in order to save energy and provide better/more comfortable lighting.
32. **Fire detection:** Early fire detection and warning.

Industry

The term "Industrie 4.0" has been heralding the coming of a new industrial revolution through smart manufacturing. The Industrial Internet of Things or "IIoT" is defined as "machines, computers and people enabling intelligent industrial operations using advanced data analytics for transformational business outcomes". Many industries in Africa are looking towards the benefits provided by IoT applications.

For example, our startup "TrackTile" (see the Magazine "WaziHub: Unlocking IoT Startups in Africa") is creating a device that can track the curing of cement.

In the following, we show several use cases for IIoT in Africa:

33. **Transport & logistics:** Monitor logistics, such the position of trucks or the quantity of goods transported.
34. **Construction:** Monitor construction processes and quality. E.g. monitor the curing of concrete.
35. **Predictive maintenance:** Use sensors and models to predict the failure of equipment, in order to maintain them on time.
36. **Renewable energies:** Monitor and optimize the production and consumption of off-grid renewable energy system.

37. **Emergency locator:** Quickly locate a person in distress.
38. **Biogas production monitoring:** Monitor biogas production especially amount of gas, pressure, temperature.
39. **Off-grid energy production/consumption:** Energy production and consumption optimisation, payment systems and fault detection.
40. **Worker safety:** Accident prevention and safety of the worker in process industries and mines.

Health

IoT is also revolutionizing the way African people are accessing healthcare. In Africa it is common for instance, that patients in remote places have to travel hundreds of kilometers to visit a doctor. The ongoing Covid-19 pandemic is also placing new demands on healthcare and creating the need for solutions that can aid in providing care remotely, far from a healthcare institution.

As an example, our startup "PregCare" (see page 28) is providing a bracelet that pregnant women can wear, providing them with vital information that can also be sent to their doctor.

In the following, we list several Healthcare IoT applications being developed in Africa:

41. **Covid & health tracking:** Monitor the health of persons, e.g. the temperature of persons entering a facility.
42. **Pregnancy monitoring:** Monitor the health parameters of pregnant women, doctor remote monitoring and consultancy.
43. **Mobility old persons:** Assist old people move around, with personalized advice and interactions.
44. **Child nutrition monitoring:** Monitor child nutrition, weight and growth.
45. **Clean cooking:** Monitor the safety of the cooking process, e.g. a smart stove that doesn't produce fumes.
46. **Hospital asset/bed tracking:** Monitor the availability of hospital assets and beds, making sure that patients are addressed to the correct hospital.

Wildlife

Africa has a renowned Wildlife, and e.g. safaris are a significant source of income in several countries. This precious resource has to be monitored and protected from poachers. Another problem are the "conflicts" that arise between humans and wildlife.

For example, the startup "N'Vodu Care" is providing a device to warn villagers that an elephant is approaching, thus preventing accidents.

In the following, we list several applications related to wildlife in Africa:

47. **Remote wildlife monitoring:** Monitor the health status and location of wild animals, such as Rhinos and elephants remotely.
48. **Illegal poaching activity:** Timely warning of illegal poaching activities.
49. **Human-Wildlife conflict prevention:** Prevent conflicts arising between humans and wildlife, for example detection of elephants getting close to villages.
50. **Bird tracking:** Track the birds for study of bird health and population.

The WAZIHUB architecture

IoT technology for Africa

The Waziup platform is a suite of ready-to-use IoT components designed for startups and entrepreneurs

Which IoT technologies are the most promising for the African market? In this dossier we will present the Waziup technologies, which has been developed specifically keeping in mind the challenges faced by entrepreneurs in the African continent. The first important factor to enable the adoption and rapid prototyping with IoT technologies is the cost. Our low cost toolchain allows any tech enthusiast to tinker and learn, with a very low initial investment.

> *Waziup technology supports easy prototyping at a low cost, for startups.*

Interoperability is also a key ingredient for a platform, in order to work easily with other systems at present or in the future. Waziup uses standard technologies such as Arduino IDE, LoRaWAN and Raspberry PI. It is compatible with all Cloud platforms.

The Waziup platform focuses on long-distance, low cost and low energy, using the technology LoRaWAN. This technology is particularly well-suited for the African countryside, where the internet is not always available. Since the internet is not always available, your applications cannot always live in the 'Cloud': they need to live in the "Edge". The WaziGate has Edge computing capacity for your applications: No Internet needed!

To achieve this, the Waziup platform combines 3 components: the WaziDev, the WaziGate and the WaziCloud. Together, they allow developers and startups to create great IoT embedded solutions. In this dossier, we'll discover how you can create great prototypes easily with Waziup, using all those technologies.

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Fast prototyping with Waziup

Waziup platform allows you to prototype your ideas, fast and easy

By Corentin Dupont

The first step in your prototyping journey is to build the hardware part of your product. For this, we have created the “WaziDev”, an easily programmable and customisable prototyping board using inexpensive Arduino technology.

The WaziDev sensing and Actuation platform fits all applications specific to applications focused on the Internet of Things, Artificial intelligence. Data can be sent up to 7Km using the LoRa technology.

The WaziDev

The WaziDev is an ideal solution for startups and entrepreneurs who want to transition and work with smart solutions. Rapid prototyping for IoT products is the new norm and making real MVPs (Minimal Viable Products) requires up to date and easy to use platforms that guide you to create your solution.

WaziDev was created to ensure compatibility with all sensors and LoRa or Arduino softwares and sensors.

WaziDev features include:

- A compatible pro Mini arduino CPU;
- RFM95W LoRa module;
- Embedded Lipo battery for solar panels and low power options;
- Two pins with high current support (500mA);
- All fully compatible with the arduino development environment.

Thanks to the proliferation of mobile devices, sensors are now remarkably affordable, meaning that you can combine inexpensive sensors and microcontroller boards to make your own devices with WaziDev.

Some sensors that can be connected to WaziDev

Any sensor can be plugged into WaziDev. Once your sensors are plugged in, it’s time to program! Open your Arduino IDE and start coding. The website www.waziup.io is full of program examples to help you through. Once your program is ready, you can flash it onto the board. It’s enough to connect the WaziDev to your PC using a USB cable, and press “upload”.

WaziDev can be programed with Arduino IDE

The Waziup.io website contains a number of links that provide you with the Arduino IDE as well as the directories.

LoRa and LoRaWAN: enabling startups in Africa

LoRa and LoRaWAN radio technologies are driving the IoT revolution in Africa

By Corentin Dupont

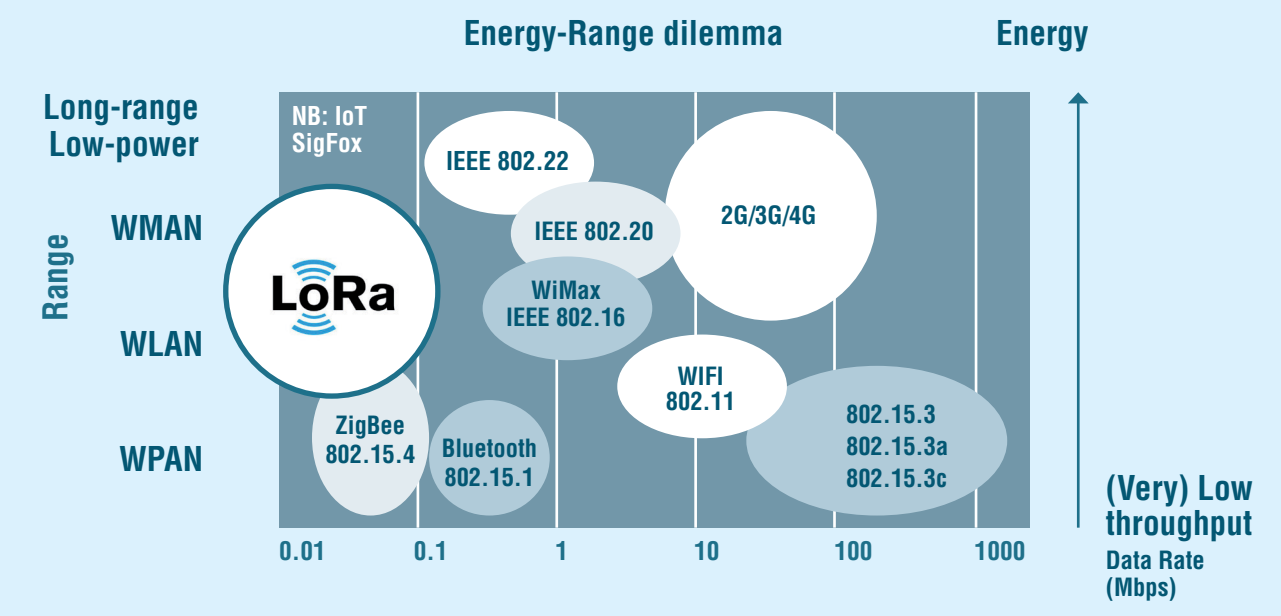
LoRa (acronym for "Long Range") and LoRaWAN (Long Range Wide Area Network) are relatively new radio technologies that are having a tremendous impact on IoT deployment worldwide. They currently use unlicensed frequency bands and the innovative physical modulation technique allows for a more than 10km range in rural areas. Its low power consumption makes it ideal for businesses to jump into the IoT world. LoRaWAN technology is widely available, affordable and easily accessible as it offers a choice of connectivity within public or private networks.

LoRa and LoRaWAN radio technologies are huge enablers for uptake of IoT in rural Africa.

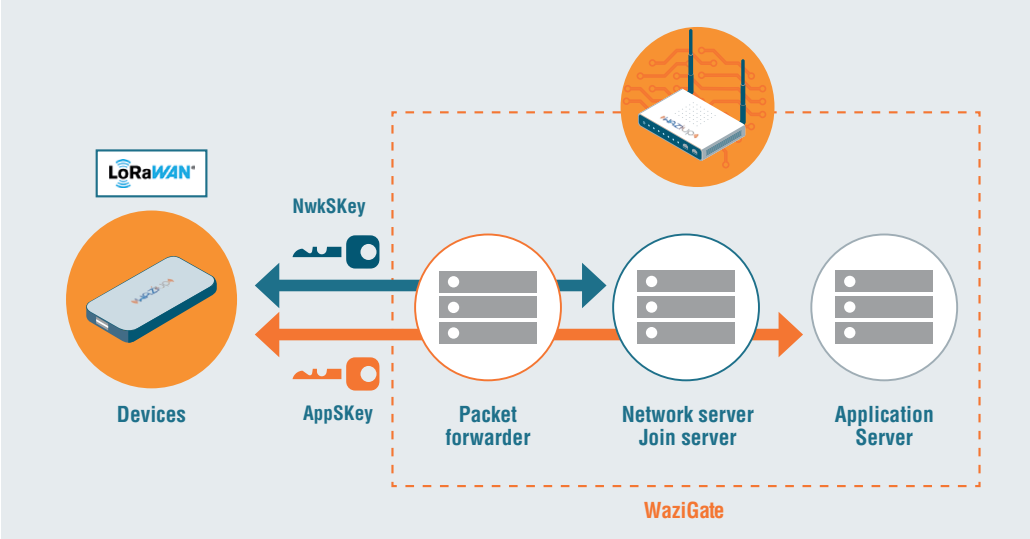
What is the difference between LoRa and LoRaWAN? LoRa is only the "radio" part: how to transmit the messages over the air. LoRaWAN adds, on top of it, the "networking" part: how the messages will be delivered to the final user.

There are many radio technologies out there. You already know many of them: 3G/4G, WiFi, Bluetooth… LoRa focuses on long range and low energy consumption. This comes at a cost: a very low bandwidth. You will not watch a film through LoRa! Each packet is only 256 bytes maximum (like a SMS).

Furthermore, if you want to reach far (several kilometers), you need to speak slowly: your message may use several seconds to be sent "on the air". After sending, your device will need to avoid speaking for some time: this is called the "fair use policy". For unlicensed frequency bands, a common policy is 1%. So, after sending your message, your device might need to switch off for several minutes. Not great for multimedia applications, but for a sensor-based IoT application, this is fine! For example, sending the soil humidity every 10 minutes, and go to sleep in-between sendings. This will also help save battery file.
LoRaWAN, on its side, will take care of delivering the messages to the final user: the LoRaWAN gateway forwards the messages to a "Network Server" which will then forward the messages to an "Application server"



LoRa vs other radio systems



The WaziGate IoT gateway

for the final user. LoRaWAN includes an end-to-end encryption scheme therefore data privacy is guaranteed. Waziup technology is equipped with end-to-end LoRaWAN with the innovative possibility to locally decrypt IoT data on the Waziup gateway. No Cloud needed!

The WaziGate is LoRa gateway ideal for all remote IOT applications up to a radius of 7km. It is able to cover over 100 sensors and actuator nodes through LoRa radio network. It spreads through a number of solutions and sensors that it can listen to when connected. The low cost gateway can even work with low internet modes or reception and still gives data to its end-users through its embedded database and web-based visualization module.
It has a ton of features that give a broad range of advantages to its users:

- Edge capacity to host your applications;
- LoRa communication up to 10-12 Km;
- Permanent Wifi hotspot;
- Wifi/3G/Ethernet internet connection;
- Data upload with HTTP, MQTT or even SMS;
- Low power consumption;
- Automation;
- Remote management.

Do you own a Raspberry PI? If yes, you're just one step away from getting a WaziGate! Just head on to www.waziup.io and download the latest version of the WaziGate software. Then, flash it onto the Raspberry SD card.

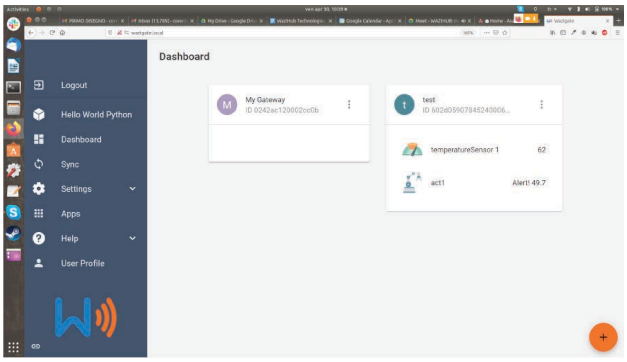
Configuring your WaziGate is simple and easy. First, you'll need to connect to your newly flashed WaziGate. You can use:

The WaziGate: a LoRaWAN gateway

- The WaziGate Hotspot;
- An ethernet cable;
- An HDMI screen.

You then need to configure the basics: WiFi and Cloud synchronization.

Your LoRaWAN gateway is now ready. It can communicate with any LoRaWAN-enabled devices, including but not limited to the WaziDev.



WaziGate UI

Edge computing IoT gateway

The WaziGate is more than a simple pipe where your data is transiting: it can process everything, at the edge

By Mojtaba Eskandari

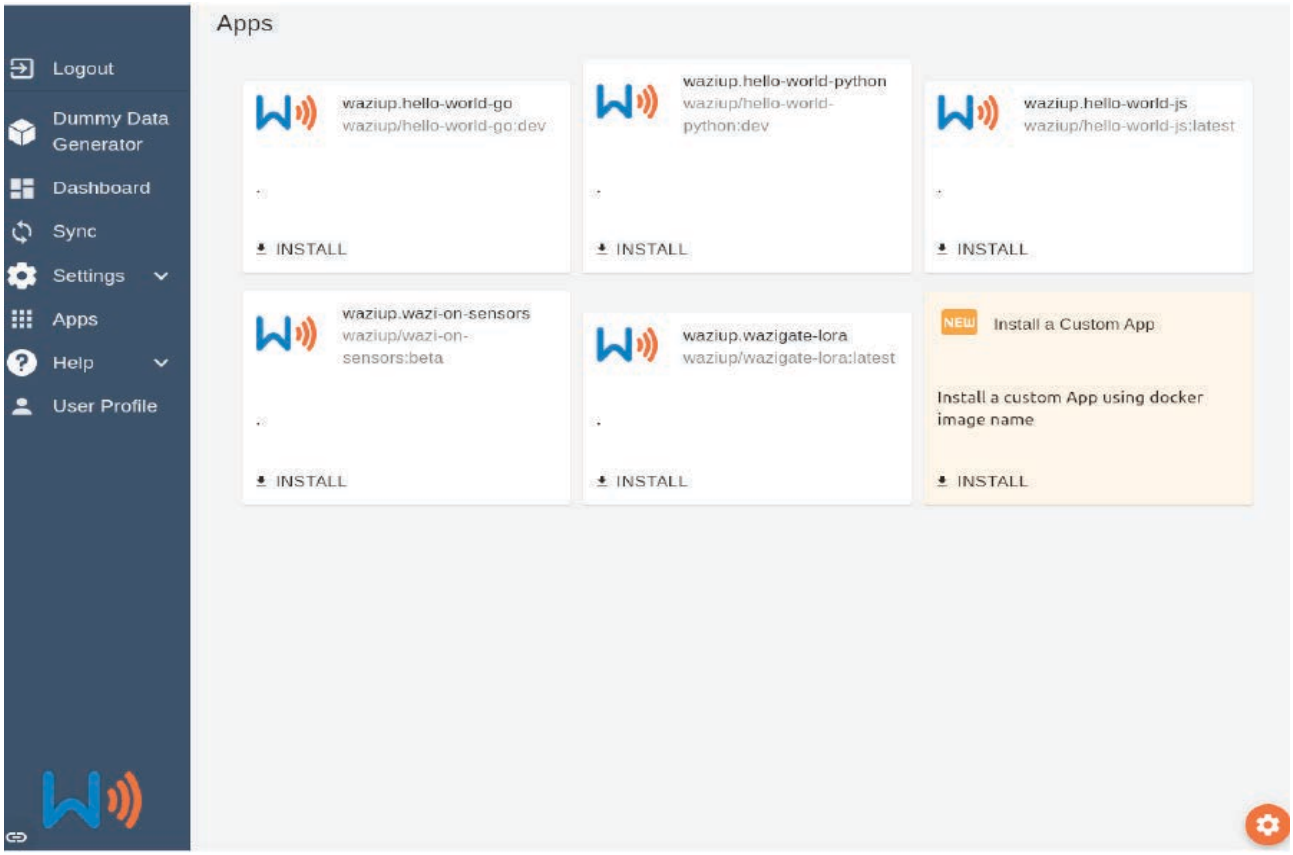
Your WaziGate is autonomous: it doesn't need the Internet to function. You can upload your applications directly on the gateway. Everything will be processed locally: your data is safe!

Wazigate uses a microservice architecture based on docker to manage its Apps. This architecture allows each application to operate independently in isolation which makes the development and maintenance much simpler than a monolithic architecture.

As a developper, you need to develop or adapt your business application for the WaziGate. This application will access all the necessary information from the WaziGate open APIs. For instance, you will get the latest update from the sensors connected to the WaziGate. From this, the application will display the information to the final user.

Your business application, living on the WaziGate, will display its own User Interface, which is automatically integrated in the WaziGate dashboard. That is to say, your application will show up in the WaziGate menu entries and be accessible to your clients, locally. Your client will just need to connect to the gateway hotspot and open the interface.

The WaziGate allows you to not only collect data from sensors, but also to trigger actuators. An actuator can be a motor, a light, a buzzer: anything that can perform an action. The distant actuators will be triggered through the LoRaWAN protocol. The actuators connected to the gateway can also be triggered through the API: that means they are accessible to your applications.



Create your own apps and great visualizations

Access, display and manage your data and users with WaziCloud

By Corentin Dupont

The WaziCloud enables you to manage your sensors, actuators and the IoT data. The wazicloud will support a developer with everything they need for their application and provide a bed of advantages among others:

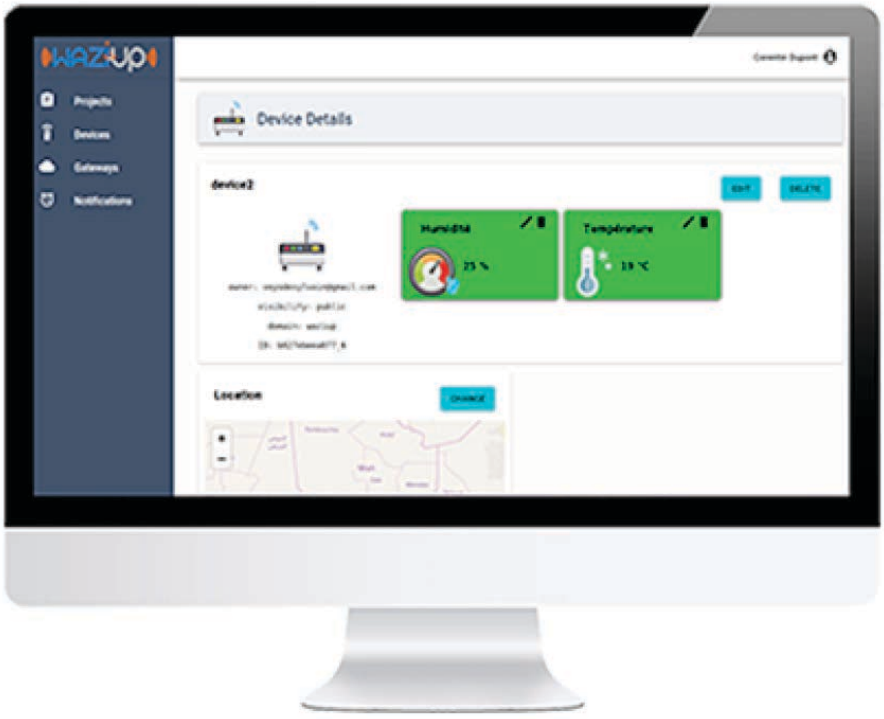
- Remote connection of your sensors and actuators;
- Send, receive, collect, store and analyze the data they generate;
- Manage your users and their privacy;
- Turn that data into actionable insights, in real time;
- Using SMS or mobile application for notification;
- Standard IoT protocols (HTTP and MQTT);
- Open REST API for application development;
- Control your gateways from remote.

Control your sensors and actuators

The WaziCloud collaborates with the WaziGate to give you full control over your sensors and actuators. LoRaWAN devices connected on your WaziGate will also appear on the WaziCloud. Your sensors values will be displayed live on the Cloud dashboard. Furthermore, the dashboard allows you to control your actuators: you can use the UI to send direct commands to your IoT devices, such as “open the door”. The WaziCloud also allows you to program simple automations directly from the UI, such as “if the temperature is more than 50 Degrees, then close the doors”.

Control your gateways

Once you have deployed your gateways in remote places, you can still access them! No need to drive there to gain access. The WaziCloud dashboard shows all your gateways and their statuses. You can access them remotely through a dedicated private “tunnel” created for your gateway.



WaziCloud dashboard

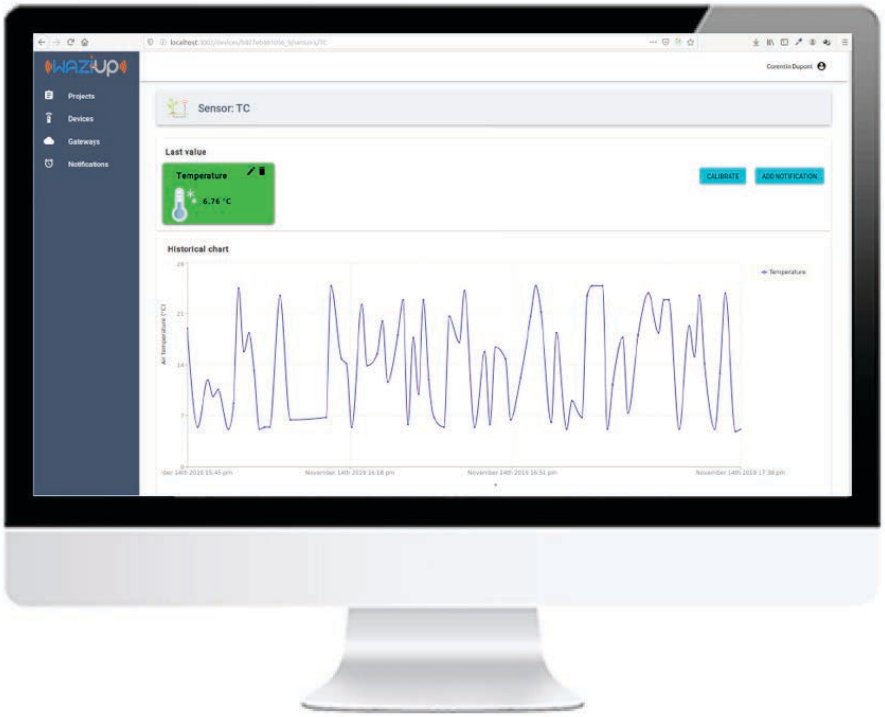
Visualize your data

A lot of sensors means a lot of data. And by a lot, we mean *a lot*. A single sensor can generate hundreds of datapoints per second. How to make sense of this huge amount of information? Waziup's visualizations help you understand what's going on.

The Cloud dashboard provides its own graphics showing the historical data for your project. Furthermore, WaziCloud is compatible with the most popular data analysis platforms out there. For instance, you can connect WaziCloud with Graphana to produce custom graphics.

Create your own apps

Your own business, your own app. For offering a tailor-made experience to your customers, WaziCloud allows you to develop a specific application for your business. Your application will connect to the WaziCloud API to collect your sensors' data in a secured way. The API gives you full control on all the IoT aspects: devices, sensors, actuators, notifications, users...



Data visualization on WaziCloud

Exclusive preview: new Waziup IoT hardware

How the new generation of hardware “Made in Waziup” can help startups and entrepreneurs

By Mojtaba Eskandari

Initially Waziup had a DIY approach where a user should purchase various pieces of hardware and wire them together in order to make, for example, a sensor node. However, there were challenges for the users as there are so many hardware components in the market and they did not know which one to choose. Moreover, a DIY device is mostly used for prototyping or hobby projects and is not reliable for real world applications. In order to resolve these issues, we decided to produce a proper set of hardware for users which can be used for serious use cases.

Waziup hardware products

Certain hardware components are required for development of an IoT product from prototype to the final product.

WaziDev is a Sensing and Actuation platform for IoT applications. It transmits data up to 7Km using the LoRa technology. It is easily programmable and customizable, using Arduino technology. It is an ideal solution for start-ups and entrepreneurs who want to rapidly prototype IoT applications.

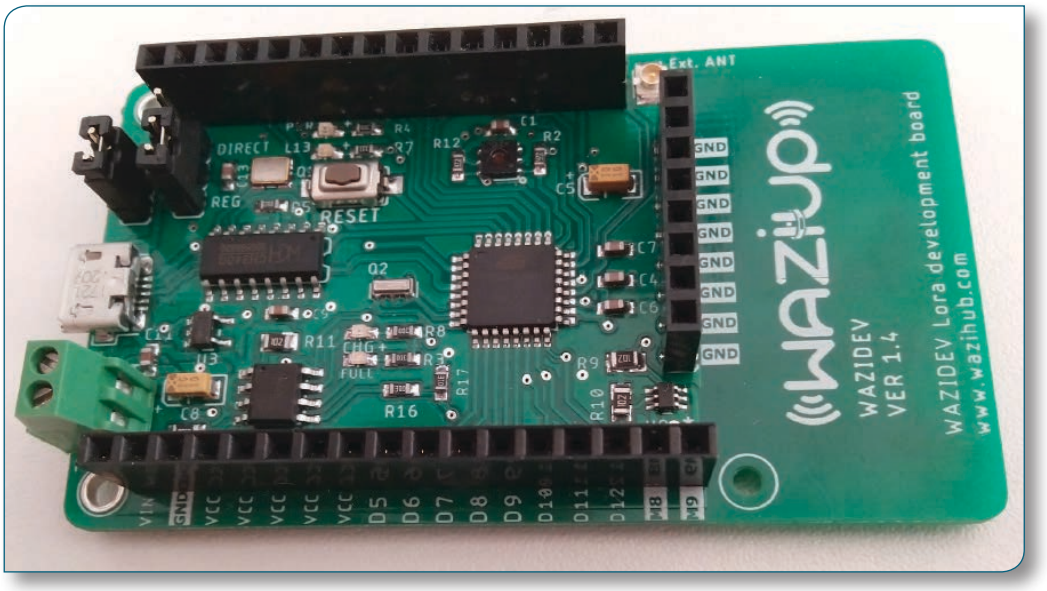
Its key features include:

- Arduino Pro Mini compatible CPU;
- RFM95W LoRa module with an embedded LoRa antenna;
- Fully compatible with the Arduino development environment;
- Embedded Lipo battery charger for solar panels and low power options;
- Two pins with high current support (500mA);
- On board temperature and relative humidity sensor.

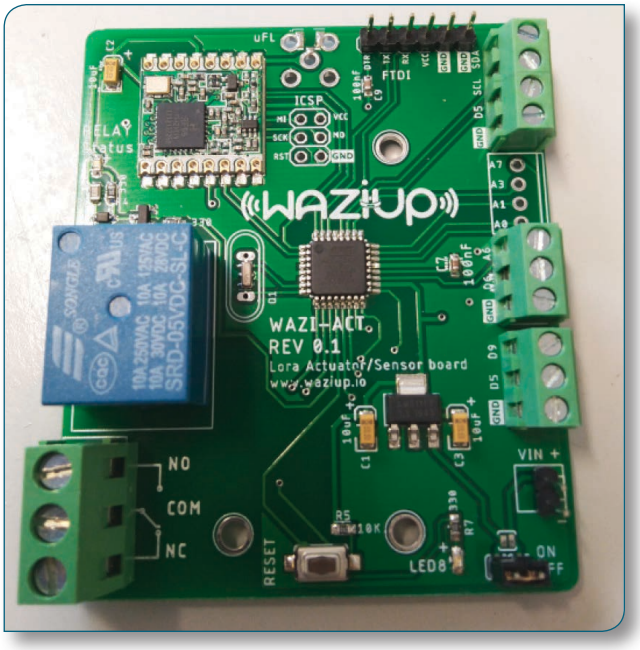
More information can be found here:
https://www.waziup.io/documentation/wazidev/

Once a startup prepares and tests their prototype, they can rapidly move to a product using WaziSense and WaziAct which are designed to be used as final products.

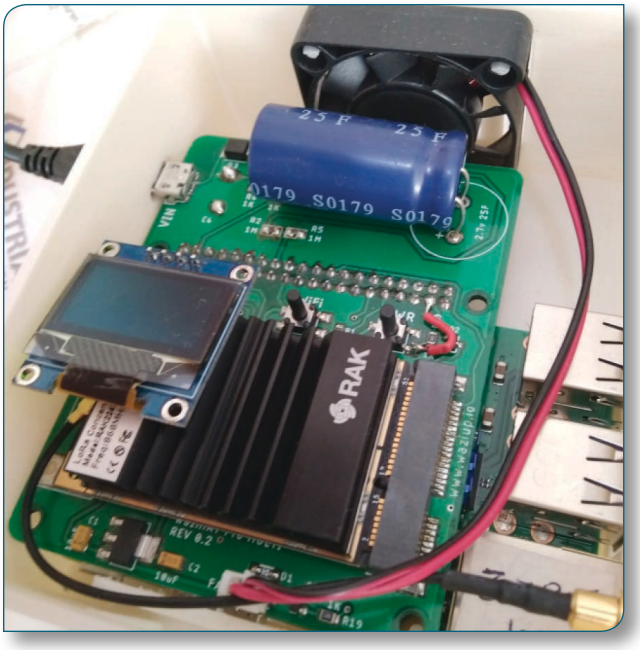
WaziSense is a battery-less LoRa sensor board with energy harvesting capability. WaziSense has a temperature and relative humidity sensor on board. It uses supercapacitor technology to store energy for data transmissions and exposes a number of terminals for external sensors and is designed to be fit into standard cases.



WaziDev V1.4



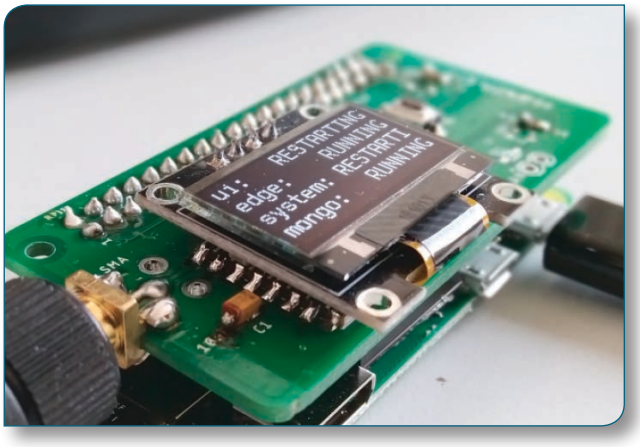
WaziAct



WaziHAT for single channel LoRa gateway

WaziAct is a LoRa actuation board designed for production. It has an embedded relay and provides a number of terminals for other actuation devices and sensors. It is designed to be fit into standard cases.
On the gateway side, Waziup has developed two Raspberry Pi HATs in order to add more capabilities to the board including LoRa connectivity, control buttons, smart fan, OLED display and a blackout protection circuit.

A combination of a **WaziHAT**, a raspberry pi and Wazigate Firmware is called WaziGate. In fact WaziGate is an IoT LoRa Gateway, ideal for a wide range of remote IoT applications. The Gateway can cover up to 100 IoT Sensors and actuator nodes using a single channel



WaziHAT for multichannel LoRa with blackout protection circuit

WaziHAT and a lot more with multichannel WaziHAT: Weather stations, soil monitoring, GPS applications, live stock tracking, fish farm, etc. The possibilities are endless! WaziGate can also control actuators, such as electro-valves. Since Wazigate is modular and edge computing capable startups can develop and host their own applications directly in the gateway, and connect to it through WiFi or Ethernet. WaziGate is designed to be able to work without Internet connectivity and still provides data to end-users through its embedded database and web-based visualization module. The WaziGate features:

- Edge capacity to host your applications;
- LoRa communication up to 10-12 Km (even more with a high quality antenna and good mounting site)
- Permanent WiFi hotspot;
- Wifi/Ethernet internet connection;
- Data upload with HTTP, MQTT or even SMS;
- Low power consumption;
- Automation;
- Remote management.

More information can be found here:
https://www.waziup.io/documentation/wazigate/

INFRASTRUCTURE DEPLOYMENT

WAZIDEV
WAZIGATE
WAZICLOUD
SENSORS

DEV Kit

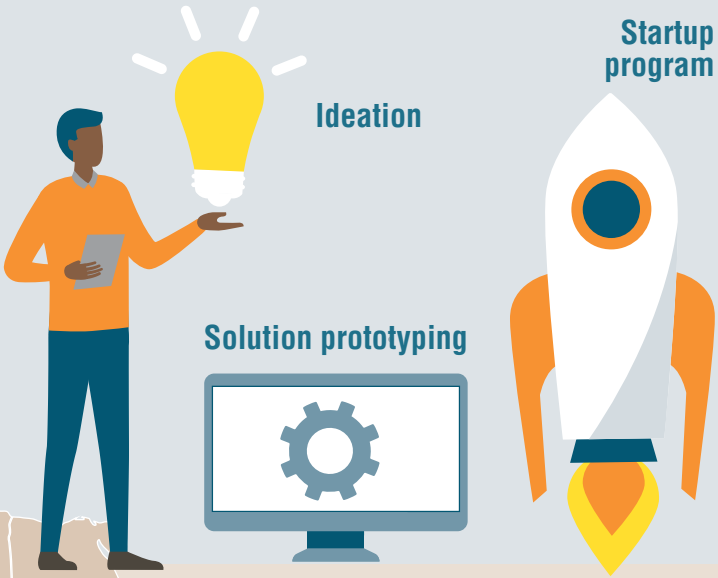
IoT CAPACITY BUILDING

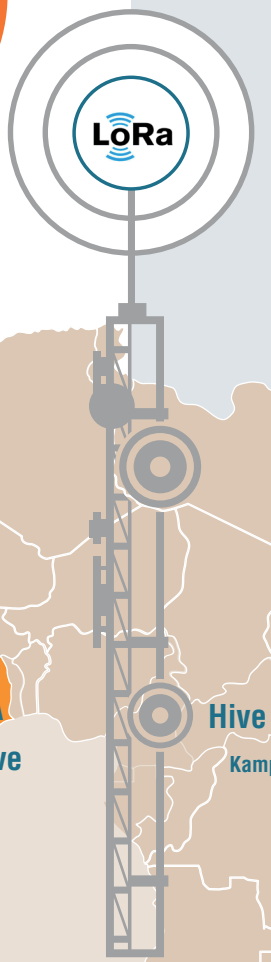
Hackathons

Ideation

Startup program

Solution prototyping





University Gaston Berger

Saint-Louis - SENEGAL

GHANA

Kumasi Hive

Hive Colab

Kampala - UGANDA

@iLabAfrica Centre

Nairobi - KENYA

Dar es Salam - TANZANIA

Dar Teknohama Business Incubator

The Makerspace Foundation

Durban -SOUTH AFRICA

WaziHub IoT deployments

WaziHub is deploying IoT gateways in several countries to enable IoT entrepreneurs

WaziHub is deploying IoT connectivity in several countries in Africa and supporting IoT startups. Our strategy rests on a network of "TechHubs": local associations promoting technologies. TechHubs are sometimes called "MakerSpaces", "FabLab", "HackerSpace"... They are an expanding phenomenon in Africa. This is where young (and not so young!) entrepreneurs gather and can experiment with new technologies, receive training and coaching.

Within the TechHubs, WaziHub strategy has been to deploy IoT infrastructure, and to perform IoT capacity building. Regarding IoT infrastructure, we deployed our permanent IoT gateways called "WaziGates" in each TechHub. Those gateways are deployed in an elevated place, such as a mast (see picture).

We also provided the "WaziKits": a box with all the equipment a startup needs to build its first IoT prototype! This includes a WaziDev board based on Arduino, a set of sensors and actuators, an access to WaziCloud and tutorials. In parallel with the infrastructure deployment, WaziHub performed many different "capacity building" actions. This range from IoT courses, Hackathons, Webinars, startup support, IoT competitions... The objective is to improve the IoT knowledge and capacity for the local entrepreneurs.

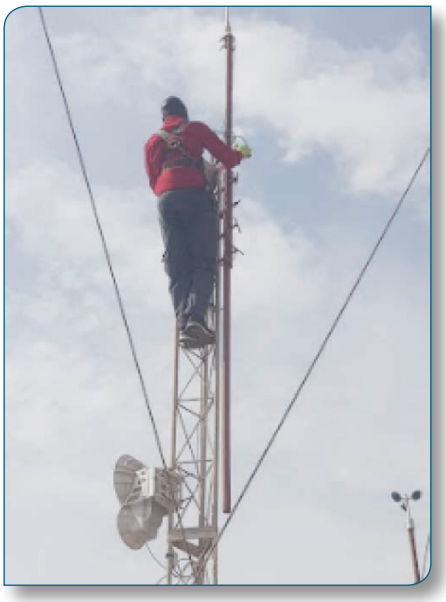
WaziHub TechHubs are located a bit everywhere in Africa: in Ghana, Tanzania, Senegal, Kenya, South Africa and Uganda. In this dossier, we will present one of our TechHubs: Kumasi Hive in Ghana. Our journey will then take us to Senegal, where the "Smart Village" experiment is taking place. Finally, two exciting startups will tell us about their experience: PregCare and AgriTechs!

Authors:

Prince Banini,
technical and training lead at Kumasi Hive,
a "Tech Hub" locatedin Kumasi, Ghana.

Wilma Sokeng
is Operation Manager for
Innotech21 GmbH.

Babacar Diop, PhD,
is an expert in the Internet of Things,
leading the Smart Village initiative
in Senegal.



Waziup gateway deployed in Senegal

Waziup in Ghana: the Kumasi Hive tech hub

Kumasi Hive is a Tech Hub in the heart of Ghana, where makers and startups can interact and learn about IoT

By Prince Banini

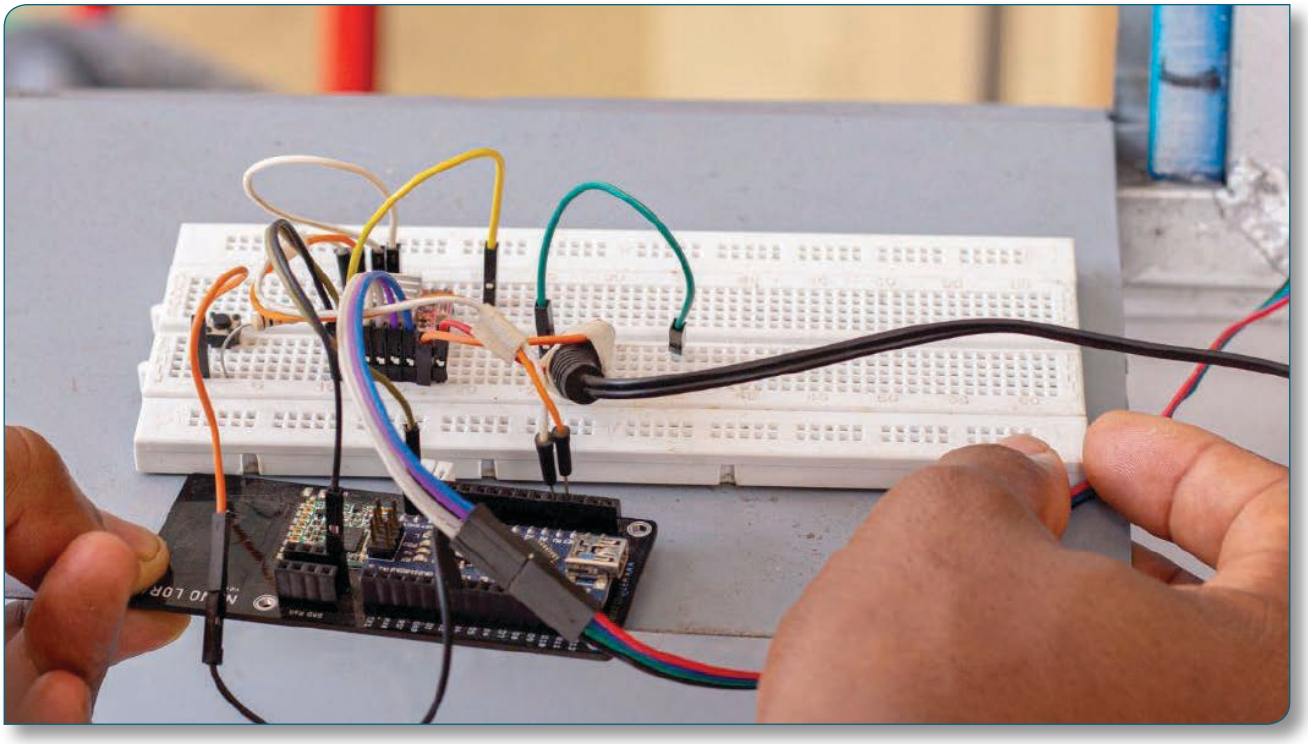
Kumasi Hive is a tech innovation space that is focused on providing access to technology, skills and equipment for sustainable job creation and employment. We are very passionate about young people because they are the future. They will grow up to become tomorrow's leaders in this digital age and will need the skills required for the digital opportunities available. For this, we organize capacity building programs especially in the field of emerging technologies, business development and entrepreneurship.

Within Kumasi Hive, the Waziup gateway (WaziGate) at has over time served a lot of makers, clients and entrepreneurs from testing of their solutions to piloting of Minimum Viable Products and deployment of functional prototypes.

The latest use of Waziup technologies at Kumasi Hive is with the Smart Bin as shown in the image below. The Smart Bin team are bringing out a solution that is not just a sustainable and effective way of keeping Ghana clean, but also an attempt to socially re-engineering the Ghanaian people, to be conscious about their environment. It pushes people to be conscious about the positive or negative effects of their day-to-day actions on the environment.

The Waziup gateway serves as the central node that relays the bins refuse state, gps location, solar panel and battery charging stats to WaziCloud. The communication between the smartbin and the gateway is done via lora technologies by means of a wazidev sensor node that serves as the heart for controlling all the electronics in the bin.

Two Kumasi Hive technical team members working on the smartbin's opening mechanism



Testing of sensors and opening mechanism in smartbin with Waziup WaziDev board

Moreover, the Waziup technologies are used to monitor the temperature and humidity of some offices at the Kumasi Hive Tech Hub to get a fair idea of which offices are warmer or need air conditioning.

WaziGate "Edge computing" is very promising and growing rapidly. If you look at many smart home IoT solutions today, you can see the central hubs increasingly now have the power to process complex sensor data, manage devices and disseminate information among nodes. Later, the results are uploaded to the Cloud for further computations. Edge computing is the next step for us.

Another technology which is not mainstream yet, but could save us on the security aspects of IoT is blockchain for IoT. Just like how blockchain works in the crypto world, IoT devices can communicate in a more secure and certified way using blockchain technologies. Hacking of IoT devices will disappear over time and will become a thing of the past. It will be extremely difficult or perhaps impossible to hack, falsify data or infest an IoT device or network with malware.

The Waziup Smart Village

The Smart Village initiative brings services based on IoT to local citizens, far from big cities!

By Babacar Diop

The Smart Village is an initiative of the WaziHub project, led by Université Gaston Berger and hosted in a village located in the suburban environment of Saint-Louis in Senegal.
The objective is to deploy a wide IoT infrastructure offered as a service to citizens and local entrepreneurs, in order to support a large range of IoT applications.
Our objectives are threefold:

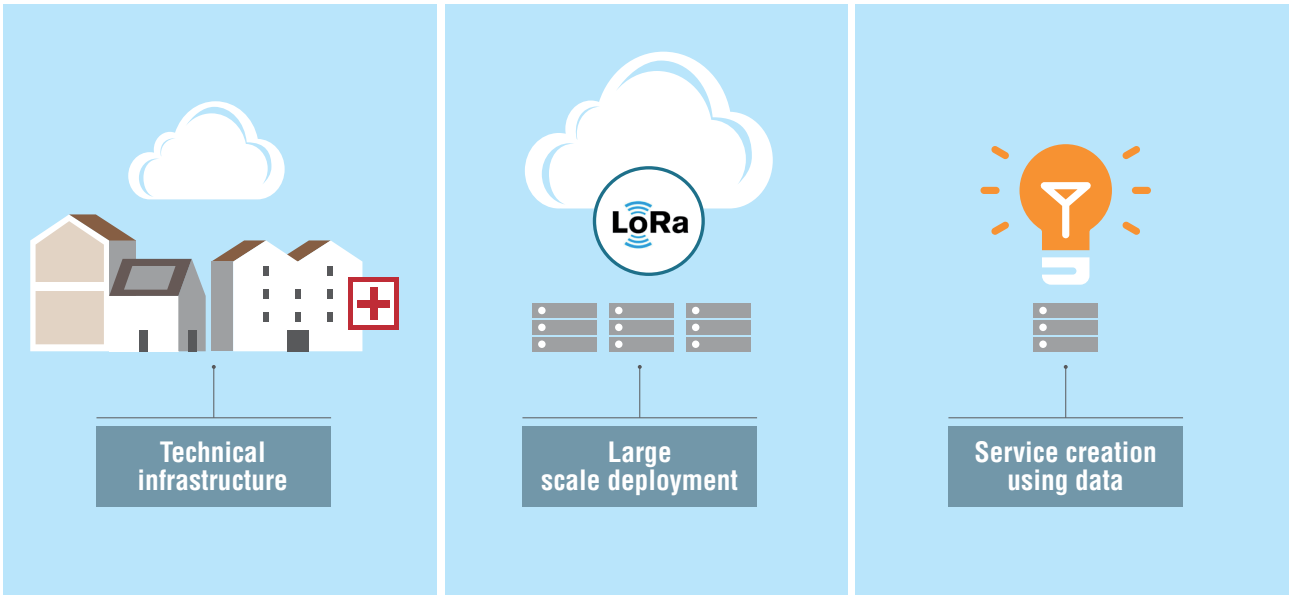
- set up a wide technical infrastructure;
- target large-scale deployment of IoT applications;
- create new services from the large collected dataset.

In order to achieve such objectives, the Smart Village has been modelled under the concept of a living lab.
We organized round tables with relevant stakeholders in order to identify together potential issues standing as obstacles for farmers, breeders and people around. On field visits were also conducted to meet the local population and trigger future collaboration and engagement. These meetings and exchanges facilitated agreement of specific areas of focus, among others: **soil quality**, **water quality**, **livestock management**, **air quality**, **weather and climate**.

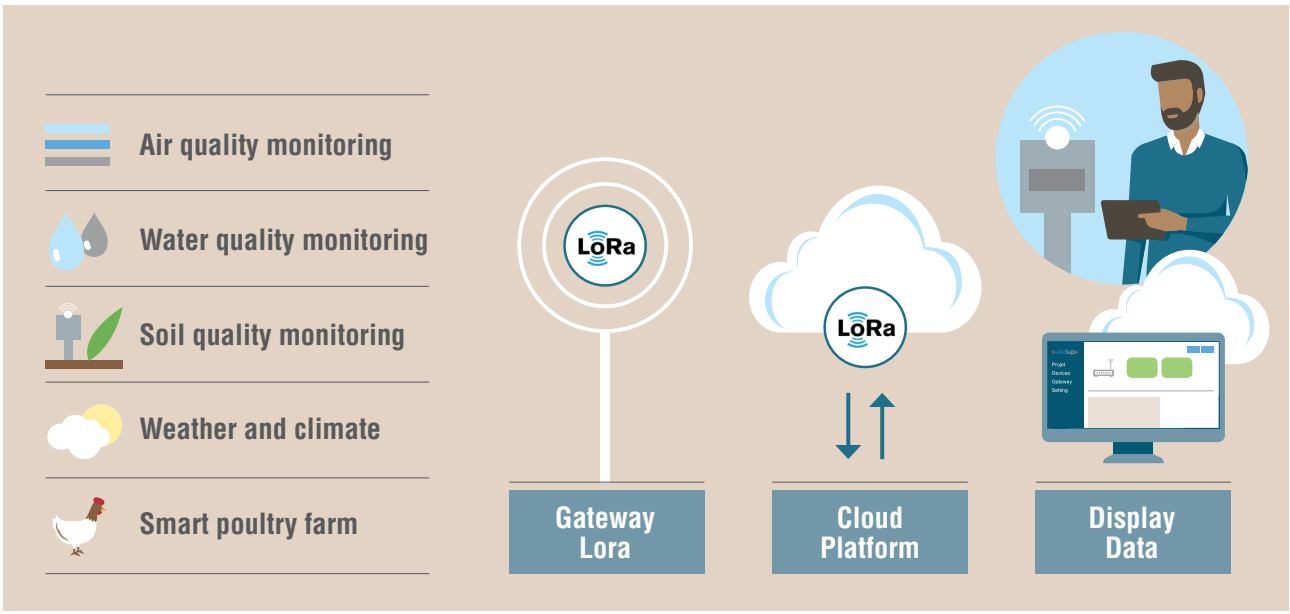
Our technical infrastructure

The Smart Village infrastructure leverages the advantages and resources granted by the Waziup, but WaziCloud and WaziDev technologies to set up a complete infrastructure. In accordance with this vision, the technical infrastructure is presented as an open infrastructure intended to support various applications. From then on, project leaders as well as developers and entrepreneurs, focus on developing the logic of their solutions and spend less effort in setting up a technical infrastructure. The infrastructure consists of the following elements:

- **Deployed LoRa gateways** that allow data collection from several devices deployed around the village;
- **The WaziCloud platform,** tightly connected to the gateways and allows the storage, analysis and restitution of data to the user through an integrated web dashboard;
- **Open-source technologies** made available by Waziup consortium including WaziDev, board series, PCB, etc.;



Smart Village activities



Smart Village applications

- **Detailed source code** and free documentation for prototyping IoT devices;
- **Technical support and follow-up** in collaboration with the local incubator and the IT computing center.

Use cases and applications

According to the area of focus previously identified, we develop proof of concepts for each one of the targeted applications.

Air quality monitoring

According to the WHO, 91% of the world population was living in places where proper air quality standards were not met. With the number of premature deaths worldwide reaching 4.2 million caused by outdoor air pollution, it becomes crucial to monitor air quality both in rural areas and cities.

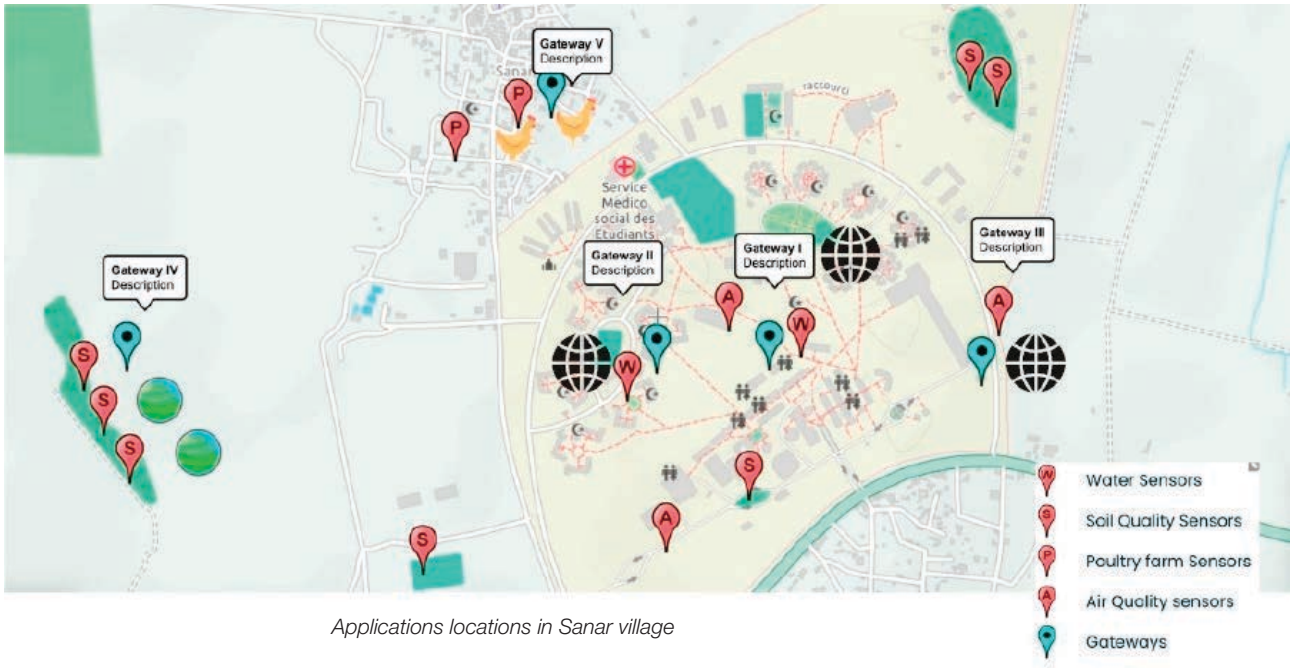
As a suburban area, air quality is one big issue in the Smart village as well as nearby towns. While the air quality index is getting worse every day worldwide, the amount of deployed AQ deployed sta-

P2.5 Pio Sensor

Near Field ozone Sensor

Near Field zone Sensor

P2.5 Pio Sensor



Applications locations in Sanar village

tions is very low in Africa, contrasting with what is noted outside. In the whole country of Senegal, we account for around less than 10 public air quality monitoring stations.
Broadly speaking, 4 air quality monitoring stations are scattered around the village. Daily collection of data is undergoing. The deployed sensors are of two types: the Nova Pm Sensor, and one purple air sensor which provides better precision but at a higher price.

Water quality monitoring

Water quality requires the use of sensors to monitor several parameters like: temperature, turbidity, dissolved oxygen, electrical conductivity and pH. For fishing activities, the range of parameters can be split into two: physical and chemical parameters. The first class refers to the presence of fine solid particles measured as turbidity, and chemical parameters. This later consists of parameters such as dissolved oxygen (DO), acidity measured through pH, salinity measured as electrical conductivity and NPK parameters.

Water quality devices have been deployed since 4 years, and preliminary results have been output with regard to the end-users fishing activities. Interesting insights have been assessed. In the Smart Village, devices able to collect these daily parameters have been used these last months for giving recommendations about the water quality of some fish ponds.

This map provides a global view of the deployment of gateways, sensors around the village. Five deployed gateways enabled proper radio coverage to collect data from several sensors around the village.

In addition to the applications being developed by the Smart Village, the infrastructure is opened for every project bearer in the field of IoT and data analysis. The living lab space helps in following up technical activities

Our gateways ready to be deployed
(Single channel low-cost LoRa gateway)

and leverage potentials made available by the ecosystem. Today, the Smart Village is working with around 10 startups located in Saint-Louis, and outside, which are actively accompanied by the Smart Village team to plan future deployment.

With the support of the incubator, the IT computing center and our partners, it is possible to achieve our core objectives by the end of the year which is large-scale deployment and data collection to allow for the creation of new services.

WaziGate deployment on top of UGB tower

Focus on our champion… PregCare!

PregCare is a startup in Uganda focusing on pregnant women health

By Wilma Sokeng

The WaziHub project launched two editions of its Innovation Competition in 6 countries: Kenya, Ghana, Senegal, Tanzania, Uganda and South Africa. The objective was to give the opportunity to young Africans to build innovative and effective IoT solutions.
PregCare is a startup based in Uganda and is working on a wrist device to monitor health vitals and location of expectant mothers.
PregCare founder Sedrick Otolo answers to our question:

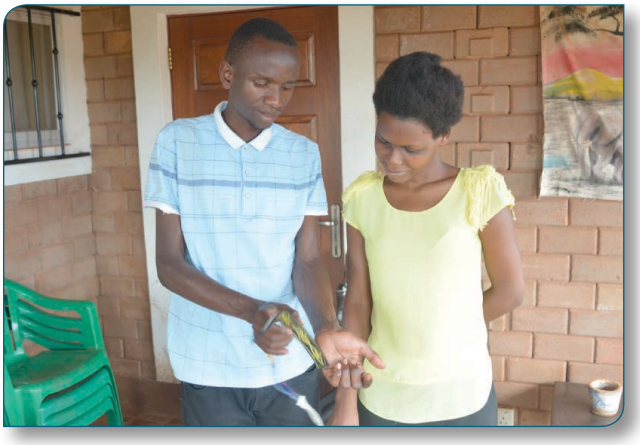
Why did you choose this idea?
We envision a world where all expectant mothers survive childbirth. The goal is to make pregnancy monitoring simple and accessible to expectant mothers in the last-mile.

In the latest United Nations estimate, 800 women die everyday from preventable pregnancy related complications. Unfortunately, 99% of it occurs in developing countries. The consequences of pregnancy related complications are tragic, expectant mothers struggle with preeclampsia failing to receive timely care. Midwives and doctors struggle in the rural and hard-to-reach areas unable to monitor health vitals of pregnant women sometimes postponing or cancelling critical procedures.

Research by the World Health Organization shows that timely monitoring of health vitals can help save the lives of women and their unborn babies. Maternal mortality in developing countries is associated with delays in reaching healthcare facilities in time and receiving treatment due to inadequate equipment. Uganda's Maternal Mortality Ratio is at 336 per 100,000 live births and is one of the highest in the world. Direct causes are estimated to be responsible for 75 to 80 percent of all maternal deaths resulting from preventable pregnancy complications.

How does your solution works?
PregCare is an IoT device that helps health workers remotely monitor health vitals of pregnant mothers in real time.
The solution works in four steps:

- *Step 1:* the expectant mother wears the hand wrist device which tracks temperature, heart-beat, pressure and gives GPS location;
- *Step 2:* The data is then sent remotely to the Doctor's dashboard where they can monitor each patient and see real time data from the device;
- *Step 3:* The expectant mother can as well visualize her health vitals on the App or get SMS on her phone;
- *Step 4:* The expectant mother can then do a Phone chat with the Doctor who can advise her on what she can do based on the data received from the device.



What makes you different?
We have seen lots of different existing solutions that are out there trying to track health information from the expectant mothers. But we have seen a great difference in the fact that our system and the device will be able to track information from them even in remote areas. Another interesting feature is that it has the capability to track offline.

What did you gain from the pilot phase with WaziHub?

- We gained a lot of experience in using the WaziHub technologies during the pilot phase;
- The business support that was offered to us was amazing;
- The financial support that was given to us at the first phase of the project was helpful.

Connecting devices to the dashboard was pretty fun and learning it was interesting. I would anyway love to learn more and how to work best with the WaziHub technologies.

How big is the market – how many potential customers can you have?

According to UNFPA, there are approximately 1,700,000 live births and 13,140 maternal deaths annually. This therefore means, we have nearly 1,713,140 potential customers and out of this number, we are targeting 10 percent, about 171,314 expectant mothers at the initial stage.

We will sell our devices to professional maternal health workers / organisations who will pay a monthly subscription fee for every expectant mother being monitored by our system.

What is your distribution strategy? How will you grow?

We have defined plans to partner with health workers / facilities or organisations who will make our devices available to expectant mothers. To facilitate our growth, we shall provide routine device maintenance and focus on marketing our product through various channels.

What are you going to do next?

We want to refine our product design and build a more complete prototype by the end of 2021, at which point we will transition into in-house testing, perform final beta tests then seek funders and high volume manufacturers.

If your startup succeeds, what additional areas might you be able to expand into?

If we are fortunate enough to succeed, we shall expand to three East African countries, to begin with, Uganda's immediate neighbour South Sudan which has the highest maternal mortality in the world, then Tanzania and Kenya whose populations are quite high.

About the founder

I am 23 years old and a software engineering student at Aptech computer education in Uganda. I'm really passionate about technology and I love Technologies so much and that has been an adventure for me.

I also love working together with young people that are more in the same age category.

Being more of a public face to so many people I speak on different occasions like schools, institutions and communities on things that inspire young people in terms of technology and their talents.

I love making podcasts on different youth topics and I am also an author of two books. *Building Great Character* and *Being Victorious* are the two books that I was able to publish and are in the market right now.

I love making new friends and more for social people and I am 85% extraverted.

Email address:
sedricksedu2@gmail.com
Video pitch:
https://youtu.be/ay0hM34qJOM

Focus on our champion… AgriTechs!

AgriTechs is a startup in Tanzania focusing on Hydroponics: off-the-ground crops

By Wilma Sokeng

AgriTechs is a startup building cutting-edge Hydroponic structures and the winner of the first edition of the Wazi-Hub Innovation Competition and is one of our Champions. We met Praygod Japhet, their Managing Director.

AGRITECHS COMPANY LIMITED

AgriTechs "Defining the future of farming"

The Horticulture industry in Tanzania is the fastest growing subsector within the agricultural sector, with an annual average growth of 10 to 12% which is far above the 3% growth of the overall agricultural sector. Vegetable production accounts for 61% of the total horticulture production. These vegetables include lettuces, spinach, amaranths, chives, mint, kale, cabbages, Swiss chard, peppers, cauliflower, baby marrow, eggplants, leeks, onions, carrots, leeks, onions, tomatoes to name a few.

In 2018, AgriTechs Company Limited started to explore the world of smart hydroponics. Smart hydroponics is a product that combines soil-less farming and Internet of Things (IoT) technologies, aiming to make climate-smart farming and urban farming affordable, profitable and convenient. With this product, our company looks to enable more horticultural farmers to farm independently of the climatic condition by creating a specific environment that a specific crop requires in order to perform well.

AgriTechs' Smart Hydroponics

The AgriTechs team

Further, the product enables farming on small spaces with up to 300% yield increase, reduces water use by 90% and saves hundreds of hours that could be used to monitor the farm manually through irrigation automation, and remote and real time monitoring of the farm through a web or mobile phone application. Additionally, the product helps to shorten crop growth periods by 25%, promotes growth of herbicides-free food, encourages precision in management to avoid losses, and undoubtedly enables farming throughout the year hence ensuring a consistent supply of healthy food to the market. So far, since August 2018, AgriTechs Company Limited has done six successful pilot projects, three at a household/small scale and three at commercial scales.

We interviewed the founder of AgriTech, Praygod Japhet:

What domain expertise do you have?
Right from its humble beginning, the company is structured to operate on a success note. The initial management team in the operations function of the company almost entirely hinges on the founders themselves, with minimal back-up requirements. However, as the company grows, it will take on board more professionals to be part of the management team. The team understands its strengths and limitations. We work hard to capitalize our strengths, and partner with highly experienced industry leaders to complement our limitations in order to meet the challenges of business dynamics.

What makes you different? What motivates you?
Helping our farmers succeed by practising controlled environment agriculture (CEA) is what motivates us. We also obtain our differentiation from having a diverse and motivated team. This helps to have much extensive yet inclusive approaches in our operations. The diversity helps us to crosscheck approaches and avoid to work in silos.

What did you gain from the pilot phase with WaziHub?
We joined WaziHub back in 2018. By the time we only had the basic hydroponics aspect of our product. After understanding how IoT works, we realized it could really complement our product. We therefore adopt-

AgriTechs demonstrator

ed IoT as a package to our product. Fast forward, we have come to realize that the IoT aspect is one of the things that interest customers most, hence giving us a key differentiation from our competitors. So we were lucky to have joined WaziHub, through which we found an interesting synergy between basic hydroponics and the internet of things.

How big is the market – how many potential customers can you have?

The market niche we are currently focusing on is dedicated to commercial vegetable farmers. The Total Addressable market in Tanzania alone is worth US$5.14 Billion, among which 34% comes from dedicated commercial vegetable farmers. Such farmers are sensitive to challenges imposed by climate changes, and are willing to employ modern technologies.

How will you make money?

We have three basic revenue models:

- The first model is to fabricate and sell the smart hydroponics to farmers, where we charge a certain percentage as the technical charge.
- The second revenue model is through selling fresh products from our small scale and commercial demonstration farms. Such fresh products include different vegetables as mentioned earlier, and are sold to outlets in the city.
- The revenue model is through after-sales-services, which includes selling products and services that a farmer with smart hydroponics needs in order to keep performing well. These may include growing supplies like fertilizers, and even consultation.

What is your distribution strategy? How will you grow?

For the past two years, we relied much on targeted marketing. With this model, we were only able to serve people of whom we knew they would buy. But as we look to grow, we are actively exploring different capacities that can help us to reach a higher number of farmers in and outside Tanzania. This involves having readymade packages that potential customers can order from different online stores, including our own website.

What are you going to do next?

Technically, the biggest assignment right now is to engineer scalable product packages. Specifically, this will focus much on breaking the technical barriers that

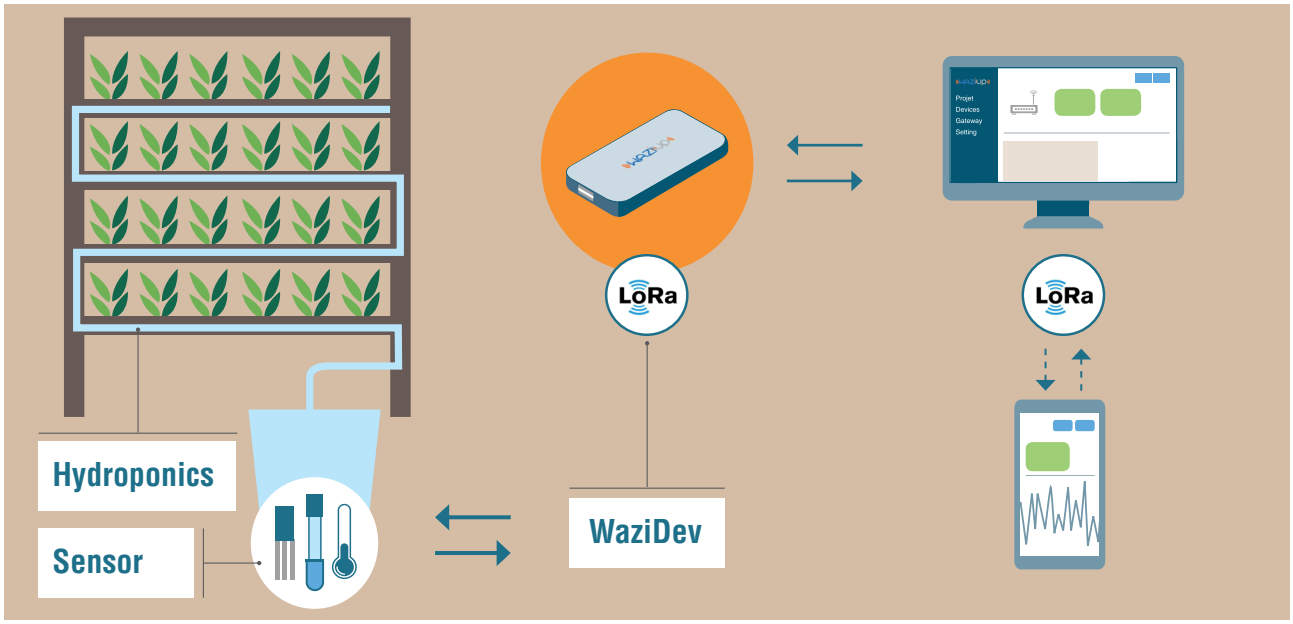
limit sales, starting from how products are fabricated (it takes time to fabricate), post fabrication functionality limitation, and all irregular patterns influenced by technical issues. The goal is to create an environment where the team can now focus on selling in order to ensure sustainability of the company.

After the proof-of-concept and finding reasonable degrees of product-market-fit, the company is now fundraising in order to focus on growth. Specifically, the company is looking to increase the team, establish a commercial scale smart hydroponics farm for customer attraction, and to establish a capacitated workshop for fabrication of the products. The company is therefore raising US$100,000.00 to accelerate its efforts in promoting and practising climate smart agriculture.

If your startup succeeds, what additional areas might you be able to expand?
Assuming success of the current projects, the company will be interested to expand its involvement in into exploring how much further can the integration between agriculture and the internet of things go, especially the use of the internet in monitoring and managing crops.

About the founder

Well, I'm Praygod Japhet, an agricultural engineer and first-time founder at AgriTechs Company Limited. I come from the North side of Tanzania, where most people are farmers. So my background with agriculture goes way back to my early days growing up as a kid. If you can't tell, I always wanted to be a farmer, but a modern one. When I came across the idea of the possibilities of integrating modern technologies with agriculture, I genuinely felt like this could be the perfect blend and then modernity I wanted. That's how I landed where I am, and I consider myself lucky and privileged to be able to work on what I always aspired. Otherwise, 'I love people who work, brains that think, and hearts that love'. I also enjoy the excitement that comes with the thought that 'it's the possibility of having a dream come true that makes life interesting'. Every day, I just try to hold onto that possibility.
I enjoy reading. I read real life biographies of interesting people of our time, about espionage, geopolitics, practical business books and innovations. I'm also a regular on Twitter, @PraygodJaphet, but I tend to enjoy reading more than tweeting.
Website: www.agritechs.co.tz
Email address: praygod@agritechs.co.tz
Video demo: https://youtu.be/BYFSA_Pu--4



AgriTechs prototype architecture

IoT in Africa: future directions

The future of IoT in Africa looks bright. Among up-and-coming technologies for IoT, we will focus on two that we see as most important for Africa: LoRa-by-satellite and Edge Artificial Intelligence.

Over 70% of the globe is not reachable via ground network infrastructure, and that is particularly true in remote zones in Africa. In the countryside, the internet is simply not always available for connecting an IoT gateway. This is where the satellites come into the picture. Very recent technologies such as LoRa-by-satellite could provide an economically efficient way to provide IoT communications. The first test satellites have just been launched!

AI is also a particularly important topic in the face of the huge amount of data produced by IoT. Without proper analytics, this data can have limited value. For instance, optimizing irrigation in Smart Agriculture can be performed using machine learning algorithms. However, AI needs to be brought closer to the user, especially when there is no Internet connection available! This is why we propose in our second article.

Authors:

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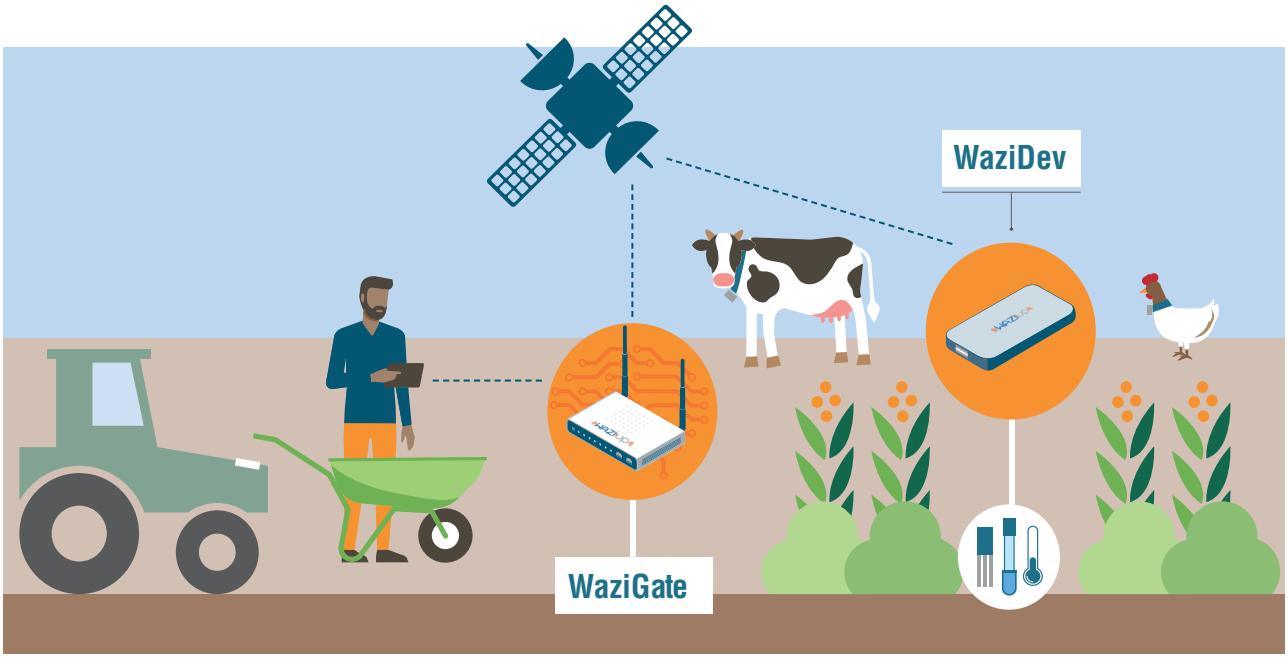
Mojtaba Eskandari, PhD,
is Product Manager at Waziup e.V.

Servane Crave
is Research & Innovation Manager at Orange Labs, France

LoRa by satellite: the next frontier

As the first “LoRa satellites” are being launched, it is time to explore the new possibilities

By Mojtaba Eskandari



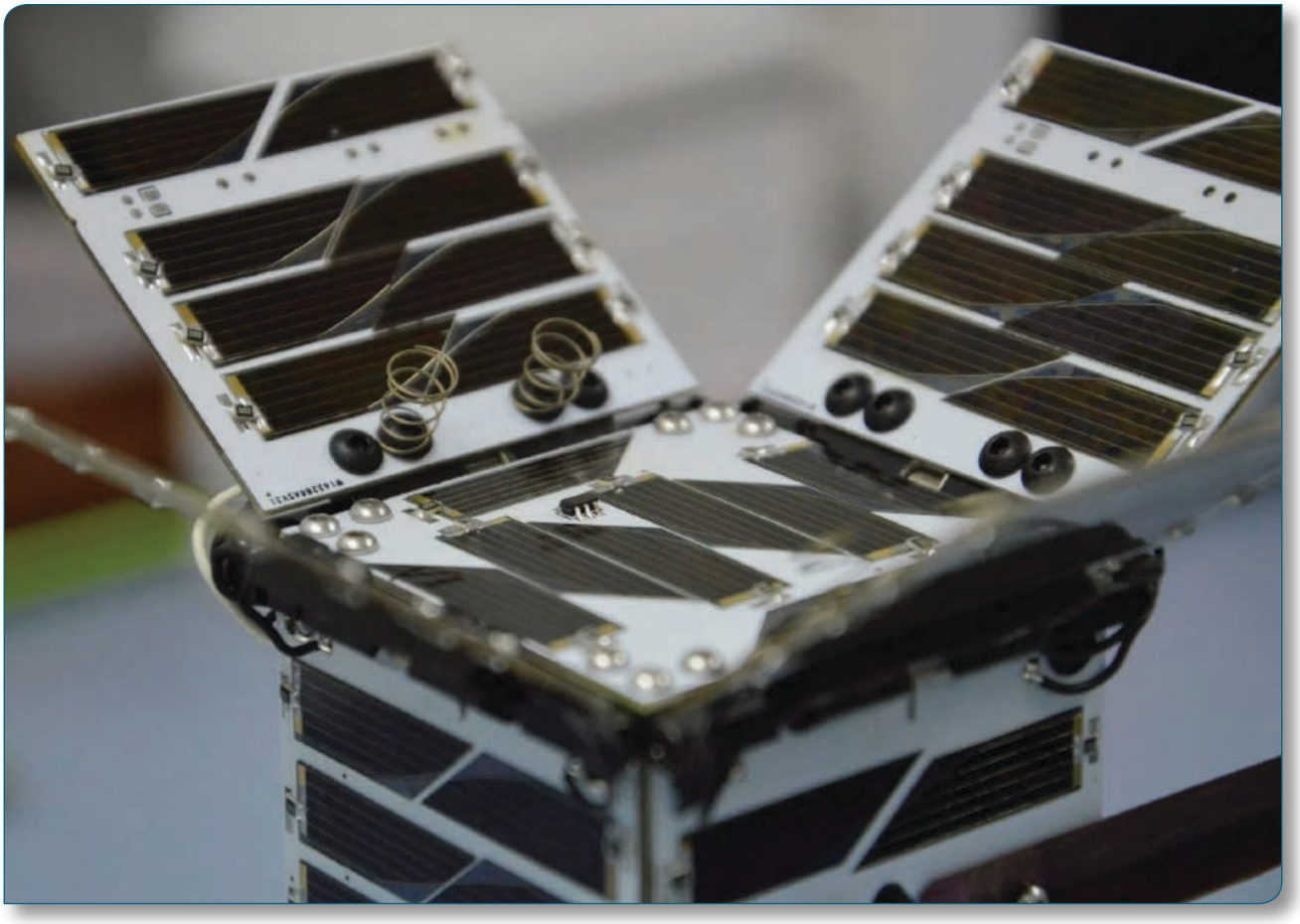
Over 70% of the globe is not reachable via ground network infrastructure. Therefore, it is not possible to deploy IoT applications in remote areas. A suitable solution would be using satellite connectivity. However, satellite devices are usually expensive and consume a significant amount of energy to transmit data; thus, not desirable for the IoT world.

LoRa has received significant attention in recent years as it is low powered and able to transmit data to a long distance. There were a number of challenges where a LoRa gateway was put into a balloon and went up to the sky in order to have a long horizontal sight and then it could receive LoRa messages from a very long distance (~700 km).

The successful LoRa message transmission in long distance was the beginning of LoRa in space adventure. FossaSat-1[1] was the first LoRa satellite to be in low earth orbit.

In fact a LoRa satellite is a small satellite which orbits at about 500K km around the earth. With many low-orbit satellites, global coverage can be achieved and this is the objective of many LoRa satellite projects and initiatives. With the appropriate hardware, an IoT LoRa device can send/receive data to/from satellites. The picture shows the specific antenna for satellite communications.

[1] https://fossa.systems/fossasat-1/



FossaSat-1: The first LoRa satellite

LoRa satellite with Waziup

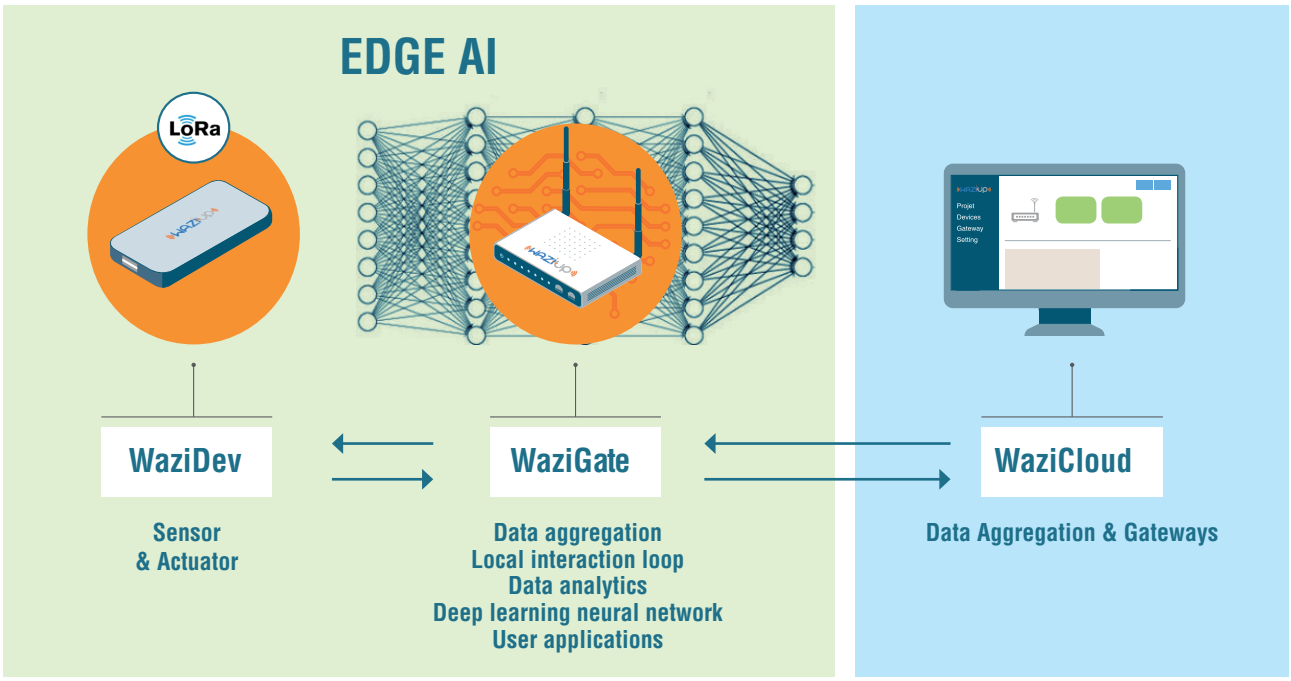
In Waziup the idea is to equip the gateway (WaziGate) with the latest LoRa chip enabling both terrestrial and satellite LoRa. As can be see in the figure, it is possible to have LoRa nodes transmitting their data to the satellite directly, however in Waziup we transmit data to WaziGate and after processing it on the gateway (WaziEdge), the aggregated data will be transmitted to the satellite and then from satellite to the ground station for further processing. The entire architecture is LoRaWAN compliant.

As an example, in a field there might be a number of soil moisture sensors, light sensors, and weather station modules. They all transmit their data to WaziGate, then WaziGate processes them locally in order to get one value for the entire field per sensor type, then it transfers it to the satellite. This scheme saves a lot of the satellite budget link and reduces the power consumption.

Edge AI: Artificial Intelligence brought closer to you

New techniques and hardware can now bring AI even closer to the users

By Congduc Pham



The Adge-AI infrastructure

Artificial Intelligence (AI) deals with the creation of systems that can learn to emulate human tasks using their prior experience and without any manual intervention, such as data analytics.

IoT and AI are both unique technologies on their own, but what makes them even more interesting is where they intersect. Without proper analytics, the huge amount of data produced by IoT devices can have limited value. This is where AI comes into the picture with specific technologies such as Machine Learning or Deep Learning.

Optimizing irrigation in Smart Agriculture is a good illustration of what IoT and AI can realize when combined together. From real-time acquisition on the soil humidity condition, advanced analytics can propose contextual recommendations for controlling the amount of water, taking into account multiple knowledge streams such as soil and crop types, agro-ecological, environmental & meteorological data to provide deeper analysis that would allow water savings and higher efficiency in the use of water.

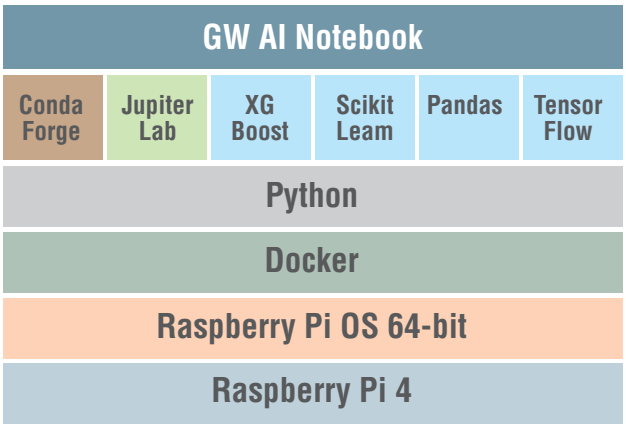
With the generalization of Cloud architectures where remote servers accessible from the Internet will realize the heavy computations, the traditional IoT & AI architecture will upload IoT data to distant servers for the AI analysis & prediction processing. While this architecture offers the maximum flexibility and transparency to applications, it requires a good and stable Internet connectivity in addition to a subscription to remote services from service providers.

“In the context of WaziHub where cutting-edge technologies such as IoT and AI must be adapted to the African context and especially to African smallholders and end-users, this traditional Cloud-based architecture has many constraints and limitations” says Pr. Congduc Pham.

With the advances on small Single-Board Computers (SBC), more processing power is made available for embedded devices than ever. For instance, the latest RaspberryPI 4 released in May 2020 can provide a 1.5 GHz 64-bit quad-core ARM Cortex-A72 processor with 8GB of RAM memory!

The WaziGate LoRa gateway using the RPI4 will therefore be able to locally run advanced and heavy AI data analytics, implementing the so-called Edge-AI architecture to bring intelligence closer to the end-users. With Edge-AI, full control on IoT data and AI processing can be realized to build a fully autonomous and intelligent system offering **plug-&-sense-&-predict** features for deploying out-of-the-box complex IoT applications in a large variety of IoT verticals.

Technical partners in WaziHub and especially the UPPA team led by Pr Congduc Pham are therefore paving the way to the next generation of IoT with Edge-AI capabilities by extending the WaziGate architecture to integrate advanced AI frameworks as illustrated in the figure below.



Our software stack

WaziGate Edge-AI gateways can then be shipped pre-configured to support a number of selected advanced AI techniques and algorithms depending on the final IoT application.

As he WaziHub project also strongly addresses the dissemination and capacity building dimension, the IoT course programme on the IoT & LoRa online tutorial (http://diy.waziup.io/#waziup_iot_courses) has been extended with chapters on AI technologies to develop these competencies in digital Innovation Hubs and tech & entrepreneur communities.

IoT infrastructure and solutions for tomorrow

What are the next steps for pushing further the IoT movement in Africa?

By Servane Crave

The major obstacle to innovation in disruptive technologies in Africa resides in the lack of access to development & testing infrastructures. There is a need to develop a solution which will provide the capacity to learn, develop, test, experiment, pilot and innovate in disruptive IoT, AI and BigData technologies. Thanks to this approach, entrepreneurs in their ideation and prototyping phase (MVP prototyping and solution-oriented capacity building for instance) will get access to state-of-the-art platforms for development & extensive testing. In parallel, bringing ready-to-use bundles to the developers' and entrepreneurs' communities is also of high importance to let them design and successfully market agriculture, health, industry, smart cities, and "green" related services.

It is with this aim in mind that the HUBiquitous project has been proposed to the European Commission and will start at beginning of May 2021. Its objective is to pave the Foundation for Disruptive Technologies in Tomorrow's Digital Innovation Hubs and to empower start-up ecosystems through sustainable collaboration of African & European Digital Innovation Hubs.
It is commonly agreed that emerging economies, instead of working through all previous iterations of a technology, are able to jump straight to the most current version: this is the leapfrog effect. However, technology per se is not sufficient to guarantee that the leap will occur: an IoT sensor does not by itself engender leapfrogging.

This is where the HUBiquitous project, with its **Solution Lab** (delivering a development & test infrastructure, and building local technical skills & competences) and **Application Business Box** (a "ready to use" integrated technical and business support package) shows its real added value. Indeed, the project will provide efficient tools to support and trigger the leapfrogging effect, by increasing technological knowledge, developing entrepreneurship skills and creating a vibrant collaborative environment for DIHs and digital entrepreneurs across Europe and Africa.

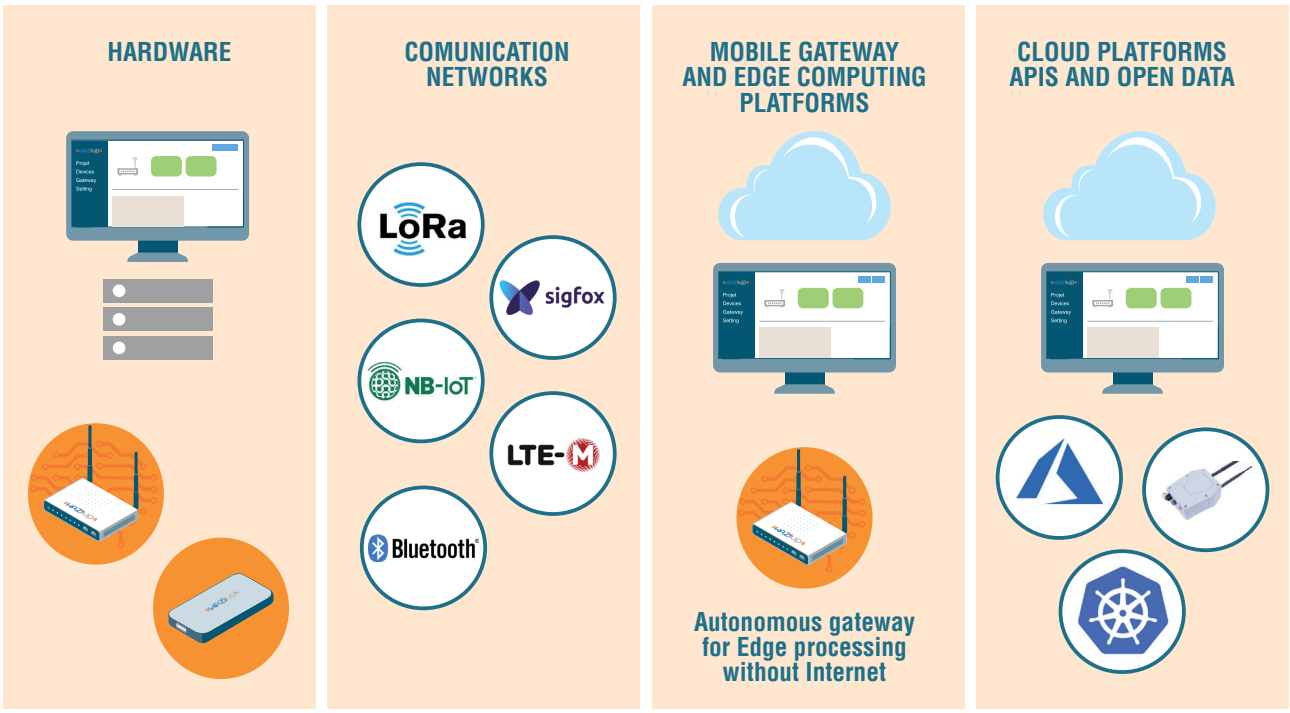
The Solution Lab is primarily a physical infrastructure proposing a number of resources as depicted in figure above: IoT, BigData/Cloud, Mobile/Edge, AI, Training and Computing resources. These resources can be hardware, software and contents/courses resources, and will be packaged in an integrated and consistent way to enable the entire infrastructure to scale-up. For instance, hardware resources will include specific state-of-the-art hardware for IoT and AI prototyping (microcontroller boards, sensors, AI accelerators, radio communication modules, etc.) while software resources will include all the software, tools, platforms, APIs required for prototyping and testing in IoT, big data & AI technologies. It is expected that once defined and packaged, the deployment of a Solution Lab can be realized in less than a month and in an incremental way.

Taking into account the African context, the Solution Lab facility seeks to provide local resources for addressing both the problem of specific hardware availability and the problem of limited or no internet availability. It will include at least the following IoT, AI and BigData technologies components:

- **Open source IoT hardware/software and rapid prototyping kits,** such as a selection of Arduino-compatible microcontroller boards (Arduino, Teensy, STM32, ...) including WaziDev (Arduino+IoT LoRa development board) developed from Wazi-up project, and a selection of sensors & electronic components for various application verticals. Ready-to-use software templates will be developed, organized, structured and made available to enable quick starting of prototyping according to application verticals.

- **Communication Networks:** Solution Lab provides a selection of radio technology modules which are used by the sensor-nodes as well as gateways in order to transmit data amongst them. Depending on the business application requirements the communication modules can include LoRa, NB-IoT, Bluetooth, WiFi, Zigbee, etc.

- **Open IoT cloud platforms for data, device and user management**, including data analytic and visualization tools. We will include the WaziCloud



Solution Lab infrastructure: testbed and experiments

platform from Waziup e.V. which communicates with WaziGate in order to collect data from sensor nodes. WaziCloud provides an extensive set of APIs and support of the MQTT protocol. It can be used by a wide range of data visualization and AI tools.

- **Mobile application development platforms** with a selection of Android/IoS platforms (smartphones & tablets) with their software development platforms. Link with IoT Cloud Platforms will enable fast prototyping of mobile applications taking advantage of IoT clouds. (e.g.Telco APIs https://developer.orange.com/products/)

- **Development tools, libraries and platforms for AI**, such as Machine Learning and Deep Learning frameworks as well as specific hardware (e.g. AI accelerators: Intel Neural Stick, Google USB Coral), libraries and possibly datasets to experiment on AI training processes.

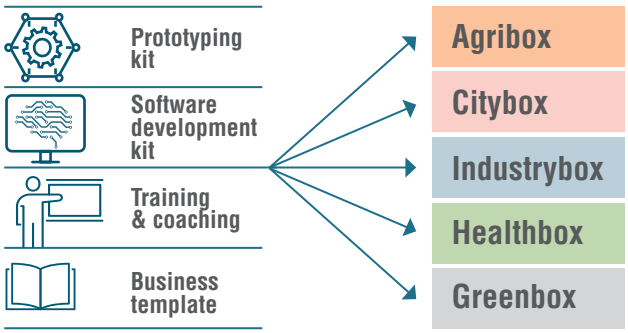
- **Edge Computing Platforms** for developing local data processing applications with no or limited Internet connectivity. The Edge Platform (WaziEdge) can be hosted in single-board computers such as RaspberryPI or BeagleBone platforms and will come with a selection of extension shields (camera, audio/sound, prototyping boards, displays, ADC,) and communication technologies such as LoRa, NB-IoT, Bluetooth, WiFi, Zigbee, etc to be able to address various application verticals. The Edge Computing Platform will also be able to embed AI-based processing modules for developing cutting-edge innovative applications.

- **Big data tools** are needed in a significant number of IoT applications which collect massive amounts of data and are required to extract meaningful information out of it. Solution Labs will provide connectivity from IoT end-devices up to open IoT cloud platforms. The cloud platforms, in question, need to provide device and user management, including data analysis and visualization tools. We will include the WaziCloud platform which will be integrated with an advanced visualization and data analysis tool. We have identified a number of these tools such as R, Kibana, Grafana, Tabular, and IVIS Framework which is developed by IT21.

- **Open data portal and infrastructure:** Various open data sources and streams such as ESA open satellite data, national open data portal, Open GIS

data, agriculture open data and WaziHub open data from deployed pilots will be leveraged by the Solution Lab to raise awareness on efficient integration of open data in cutting-edge IoT, AI and BigData applications.

- **Test-bed and experimental infrastructure,** through the deployment of Solution Labs in DIHs across Africa, HUBiquitous will initiate the deployment of open test-bed infrastructures at the continent ecosystem level so that all the DIHs and ecosystem actors can use it. Solution Labs will also link with existing open test-beds and infrastructures such as the Smart Village infrastructure developed in Saint-Louis, Senegal in WaziHub project to provide larger scale experimentations. It is important to mention that the availability of test infrastructures is very important for startups and entrepreneurs to test innovative solutions.



Application Business Boxes

Simultaneously, the project will develop the Application Business Box which is the **application-oriented business instance of the Solution Lab**. The objective of the Application Business Box concept is to provide the "ready-to-use" technical and business support to entrepreneurs and startups on 5 vertical domains (agriculture, smart cities, industry, health and environmental preservation). The idea is to propose an innovative technological & business package composed of 3 essential support elements: hardware prototyping kits & software templates, training contents (both technical and business oriented contents) and business support templates.
Each of the 5 Application Business Box will include a specific set of tools, recommendations and guidelines:

Technical kits: Application domain specific integrated hardware and software prototyping kit and dedicated APIs for emerging technologies such as IoT, AI and Big Data. The kits will maximize the usage of open-source resources. These technical kits will include, for instance, specific hardware development boards with on board microcontroller, electronic components & sensors, and radio communication modules. The kit also includes the edge devices & gateways configured for specific edge/cloud platforms and API.
Training & capacity building: Support training as well as online courses for the technical as well as entrepreneurial skills development to make use of the Application Business Boxes.

Business templates: Business components such as business plans, business acceleration support/programmes, business partnerships, networking, matchmaking with the African and European ecosystem through MeetHub. Business Templates will allow the Application Business Box to deliver valuable resources and advice to entrepreneurs/Startups.

More on our websites:

www.waziup.io
www.wazihub.com