WAZIUP Online Course

Developing IoT Solutions with WAZIUP

A-IOT-2: LoRa/LoRaWAN with WAZIUP

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham
Université de Pau, France

IoT – from idea to reality
ON-LINE ARDUINO SENSORS AND DIY LORA TUTORIAL

Forewords

This online tutorial on Arduino, Sensors, and LoRa technologies has been developed by University of Pau, France, in the and WAZIHUB projects funded by the European Union in the H2020 research program. The main objective of this online comprehensive and guided training materials to be used in training, hackathons, bootcamps, entrepreneur's days... in WAZIHUB/WAZIHUB across Africa. The main contributors are Nourou Diop, Muhammad Elhajel and Congduc Pham. The focus is on LoRa networks and IoT but this tutorial first start with basic of Arduino and sensor programming to understand that are the foundation of so-called Internet-of-Things (IoT) concepts. Then in a second step, we will introduce LoRa radio show how to build low-cost, long-range and energy-efficient IoT devices.

WAZIHUB is a technology-driven EU Africa project open-source IoT and end-to-end sensors network platform, specialized to meet African needs: low-cost, energy, internet connectivity and simplicity. Scientific leader of the “Open IoT sensing and platform” workpackage which tasks are to develop and long-range LoRaWAN framework. Interested resources from our GitHub on the low-cost LoRa from Congduc Pham's tutoriels/docs web page.

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

WAZIHUB IoT Courses

For users who wants to gain knowledge on IoT in a step-by-step lecture mode, we have defined the following courses:

1. Fundamentals of IoT
   a. What is IoT
      i. Quick Introduction to IoT - [1422]
      ii. IoT and Big Data Platform - [1422]
      iii. What is IoT - What Does the Internet of Things Mean? - YouTube
      iv. Radio - Internet of Things (IoT) | What is IoT | How It Works? - YouTube
      v. Geospatial IoT - IoT: What is Internet of Things? - YouTube
      vi. IBM Think Academy - How It Works: Internet of Things? - YouTube
   b. Introduction to Basic Electronics
      i. Introduction to Basic Electronics - [1422]
      ii. Basic Electronics - [1422]
   c. Internet of Things - Part I
      i. Internet of Things - [1422]

Advanced understanding

1. A-IOT-1: LoRa & LoRaWAN explained - WAZI
2. A-IOT-2: LoRaWAN with WAZIHUB - WAZI
3. A-CLOUD-1: WAZIHUB cloud API reference - WAZI

Prototyping and Testing: Getting started with WAZIHUB Gateways

1. D-IOT-1: Building & Configuring a WAZIHUB LoRa Gateway with Raspberry Pi - [1422]
   a. Quick overview of WAZIHUB gateway - [1422]
   b. Installing gateway software on 50 card - [1422]
   c. Connecting to Gateway and Basic Linux Commands - [1422]
   d. Configuring Gateway and Setting up Internet Access - [1422]
2. D-IOT-2: A Gateway Web Admin Interface - [1422]
3. D-IOT-3: Migrating & Using WazeGate distribution - [1422]

Prototyping and Testing: Deployment Guidelines

1. D-IOT-2: WAZIHUB IoT and Gateway Deployment Guidelines - [1422]
Outline

- Review of WAZIUP objectives and IoT LoRa solutions
- Presentation of LoRa & LoRaWAN support in WAZIUP
- Configuring a single-channel WAZIUP gateway for LoRaWAN
- Configuring a multi-channel WAZIUP gateway for LoRaWAN
WAZIUP Open IoT and Big data platform for Africans, by Africans

Affordable technologies to empower rural economics

Exploit advanced research capitalizing on IoT and Big data state-of-the-art findings

Do more with less

Develop IoT solutions and applications meeting African needs

www.waziup.eu

Waziup IoT

Waziup

Waziup

waziup.community@create-net.org
IoT in developing countries & rural areas

- Developing countries/rural areas are still far from being ready to enjoy the smallest benefit of IoT
  - lack of infrastructure
  - high cost of hardware
  - complexity in deployment
  - lack of technological eco-system and background

- To deploy IoT in developing countries, it is necessary to target three major issues
  - reduce cost of infrastructures, hardware and services
  - limit dependancy to proprietary infrastructures and provide local interaction models
  - target technology appropriation, push for local business models
Making IoT happening!

Innovative IoT technologies

"IoT for All" paradigm

IoT infrastructures and use cases

Innovative solutions adapted to local needs

Users/Developers engagement

Knowledge dissemination & training

Exploitation plan and innovation hubs

Communication & community building

Sustainable & long-term innovation
WAZIUP technology
Generic IoT v.s. highly specialized

- Build low-cost, low-power, generic, open IoT platform
- Methodology for low-cost platform design
- Technology transfers to user communities, economic actors, stakeholders,…

Physical sensor mgmt + AES encryption = Long-range transmission + Activity duty-cycle, low power + Logical sensor mgmt

https://github.com/CongducPham/LowCostLoRaGw/tree/master/Arduino
**WAZIUP technology**
**Open, versatile simple DIY IoT gateway**

- **WaziGate**
  - Based on Raspberry PI
  - Can use simple LoRa radio module for a single-channel gateway: 1 frequency, 1 SF
  - Modular & open architecture to easily add new features
  - Can push to any cloud platform as well as using SMS

http://www.waziup.io/documentation/wazigate/
WAZIUP technology
Allows autonomous gateway for no Internet scenario

Link to a short demo video of the collar web interface: https://youtu.be/meFDav1SLPI
WaziGate architecture
referred to as WaziGate SW

Data post-processing stage

- Handle downlink data
- AES encryption decryption
- LoRaWAN interoperability
- Post-processing
- Incoming data parsing block
- Handle data from other radio interfaces
- Monitor gateway temperature
- Periodic task

Cloud definition
cloud_script_1  cloud_script_2  cloud_script_n

user/app-specific

Internet clouds

Latest version at https://github.com/CongducPham/LowCostLoRaGw/tree/master/gw_full_latest
Extending with multi-channel support referred to as Wazi–LoRaWAN gateway

- Use an SX1301-based concentrator shield for Raspberry
- A data formatter will link the LoRaWAN Packet forwarder to the WaziGate SW
- A LoRaWAN cloud module will push data to the LoRaWAN Network Server while other Internet clouds are also supported.
More choices with WAZIUP!

- WAZIUP gateway has an open architecture
  - high-level language scripting, higher-level of flexibility
  - easy customization according to the application and deployment needs,
  - any "cloud" systems can be used to receive uplink data from devices
  - can also handle no-internet scenarios

- The WaziGate software can be used to build
  - Low-cost single channel gateways for small scale, adhoc LoRa/LoRaWAN deployments
  - Low-cost multi-channel gateways for medium to large scale, adhoc LoRa/LoRaWAN deployments
  - Low-cost multi-channel gateways for large-scale, both adhoc and public LoRaWAN deployments
Downlink and OTAA support

- Full LoRaWAN features are provided with WAZI-LoRaWAN gateway with SX1301-concentrator shield
  - See A-IOT-1 course on LoRaWAN
- Limited LoRaWAN features with single-channel WaziGate
  - Device and gateway must be on the same frequency and LoRa setting. For instance in EU868 band, it will be 868.1MHz & SF12BW125 by default
  - For downlink, both RX1 and RX2 windows are supported
  - For OTAA (join-request & join-accept), join-accept must use the same setting than regular data uplink LoRa setting, e.g. 868.1MHz & SF12BW125
- Programming end-devices using LMIC stack ensures maximum LoRaWAN features
**WAZIUP deployment scenario**

LoRa pkt w/ WaziGate & WaziCloud

- **Single-channel**
- **Incoming data parsing block**
- Handle downlink data
- AES encryption decryption
- **LoRaWAN interoperability**
- **Post-processing**
- **Periodic task**
- **Monitor gateway temperature**
- **Handle data from other radio interfaces**

**DIY WAZIUP LoRa device**

**DIY WaziGate**

**WaziGate SW**

**WaziCloud**

Very low-cost solution for small-holders, allowing also local processing/visualization
WAZIUP deployment scenario
LoRaWAN pkt w/ WaziGate & WaziCloud
NO edge decryption

Increased security as LoRaWAN packet are encrypted
WAZIUP deployment scenario
LoRaWAN pkt w/ WaziGate & WaziCloud
WITH edge decryption

DIY WAZIUP LoRa device
LoRaWAN pkt format

DIY WaziGate
WaziGate SW
With edge decryption

WaziCloud

Increased security and enables edge processing features
WAZIUP deployment scenario
LoRaWAN pkt w/ WaziGate & LoRaWAN cloud

Contributes to LoRaWAN (TTN,…) community
Uses existing LoRaWAN Network Server to manage gateways

DIY WAZIUP LoRa device
LoRaWAN pkt format

DIY WaziGate

WaziGate SW

LoRaWAN cloud

NwkSKey & AppSKey
WAZIUP deployment scenario
LoRaWAN pkt w/ DIY Wazi–LoRaWAN gw
+ WaziGate SW + WaziCloud/LoRaWAN cloud

NO edge decryption

DIY WAZIUP LoRa device
LoRaWAN pkt format

LoRaWAN packet
NwkSKey & AppSKey

Better scalability, full LoRaWAN and keeps the flexibility of WaziGate SW
WAZIUP deployment scenario
LoRaWAN pkt w/ DIY Wazi–LoRaWAN gw
+ WaziGate SW + WaziCloud/LoRaWAN cloud
WITH edge decryption

Full LoRaWAN, flexibility of WaziGate SW and enables edge processing features
WAZIUP deployment scenario
LoRaWAN pkt w/ LoRaWAN gw & cloud -> WaziCloud

DIY WAZIUP LoRa device
LoRaWAN pkt format

WaziDev

LoRaWAN packet
NwkSKey & AppSKey

Deployed LoRaWAN gateway w/ roaming

LoRaWAN cloud
NwkSKey & AppSKey

Benefits from a large density of gateways & keeps WaziCloud data analysis features
Gateway alternatives summary

Single-channel

- DIY, open & versatile, very low-cost, DIY outdoor version possible. Limited LoRaWAN
- Suitable for small deployment scenarios. 1 organization = 1 application = 1 gateway
- Hundredth of devices can be supported

Multi-channel

- DIY full LoRaWAN, open & versatile, low-cost, DIY outdoor version possible
- Take full advantage of recent low-cost LoRaWAN DIY gateways
- Hundredth of devices can be supported
- Full LoRaWAN, medium to high cost. Usually outdoor-ready and usually not open SW/HW architecture
- A LoRa Network Provider is mandatory
Configuring WaziGate for LoRaWAN

- set "radio_conf"["mode"] to 11 in gateway_conf.json to configure for LoRaWAN reception on single channel
- set "gateway_conf"["raw"] to true in gateway_conf.json
- set "gateway_conf"["aes_lorawan"] to false to push encrypted data to TTN (already as default setting)
- gateway will be configured with BW=125MHz, CR=4/5, SF=12
- the frequency is set by default to 868.1MHz for BAND868, 923.2MHz for BAND900 and 433.175 for BAND433
- Enable TheThingsNetwork cloud in "lorawan_encrypted_clouds" section of clouds.json (already as default setting)
- You can also use the web admin interface
The SD card image has already the Semtech's LoRa gateway concentrator and LoRa packet forwarder software installed in /opt/ttn-gateway

In /home/pi/lora_gateway/scripts/rak2245-rak831, run the following command

> ./install_lpf.sh

When prompted for "configure gateway for TTN Y/N" answer Y if you want to use TTN cloud and interface

When prompted for "run gateway at boot Y/N" answer Y

The default global_conf.json is for EU 868 frequency plan

A local ChirpStack Network Server can also be enabled
You can install a specific `global_conf.json` file to define another frequency plan for the concentrator using the web admin interface in the radio configuration menu.
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