Demo: Deploying Low-cost, Long-range Innovative IoT with the WAZIUP IoT/Gateway Framework

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Abstract

Developing countries are facing many difficulties when it comes to real deployment of IoT solutions especially in remote and rural areas. We showcase the EU H2020 WAZIUP project aiming at building an open IoT platform tailored to the specific requirements and constraints of developing countries. We will show how an 100% DIY approach can be proposed to get a very affordable yet highly efficient IoT framework proposing many features that are lacking in commercial products.

1 Introduction

The opportunity for ICT intervention in developing countries is huge especially for IoT and big data. The era of IoT can connect a large variety of sensors, devices, equipment, systems. In turn, the challenge is about driving business outcomes, consumer benefits, and the creation of new value. However, developing countries are facing many difficulties – lack of infrastructure, high cost of hardware, complexity in deployment, lack of technological eco-system and background, etc – when it comes to real deployment of IoT solutions [1], especially in remote and rural areas. At the same time, it is urgent to promote IoT worldwide and not only for developed countries market.

The EU H2020 WAZIUP project (grant agreement No 687607) contributes by reducing part of this technology gap. WAZIUP is focusing particularly in deploying IoT and Big Data platforms for sub-saharan African countries but many of its core propositions target developing countries is general. In this context, IoT deployment must address four major issues: (a) Longer range for rural access, (b) Cost of hardware and services, (c) Limit dependancy to proprietary infrastructures and (d) Provide local interaction models.

For longer range, recent Low-Power Wide Area Networks (LPWAN) technologies for Internet-of-Things (IoT) introduced by Sigfox and Semtech's LoRa$^{\text{TM}}$are currently gaining incredible interest and are under intense deployment campaigns worldwide. They offer several kilometers range without relay nodes to reach a central gateway, thus greatly simplifying large-scale deployment of IoT devices as opposed to the complex multi-hop approach needed by short-range radio technologies. Most of these long-range technologies can achieve 15km or higher range in line-of-sight (LOS) condition and about 2km-4km in non-LOS conditions such as in dense urban/city environments. When considering cost, network availability and versatility, LoRa technology [2], which can be privately deployed in a given area without any service subscription, has a clear advantage over Sigfox which coverage is entirely operator-managed.

2 The WAZIUP IoT Platform

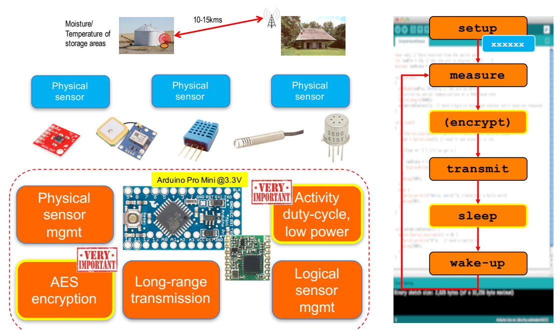

Figure 1. Generic IoT platform

The framework consists in code templates and libraries for building both LoRa IoT devices and gateways [3]. For devices, the small form factor Arduino Pro Mini board that is available in the 3.3v & 8MHz version for much lower power consumption can definitely be used to provide a generic low-cost IoT platform as it can be purchased for less than 2 euro from Chinese manufacturers. For more demanding IoT applications we use the Teensy family boards (LC/31/32) that offer state-of-the-art micro-controllers with more memory and advanced power management features at a very reasonable cost (about 10 euro for the LC). Data encryption and low-power management building blocks offer security and several years of autonomy with these off-the-shelves components, see Fig. 1.

2.1 Innovative Image Sensing

The platform also proposes innovative image sensor device based on a Teensy3.2 board that drives the CMOS uCamII/III camera [4]. We retrieve raw 128x128 8-bpp grey scale images from the uCamII to run an optimized image compression on the board that provides a robust bit stream and the possibility to decode with an arbitrary number of image packets. Fig. 2 shows the image sensor device and some image samples when varying the quality factor Q. The image sensor can either send image in a periodic manner or can run an image change detection mechanism to only send an image when there are significant changes in the scene.

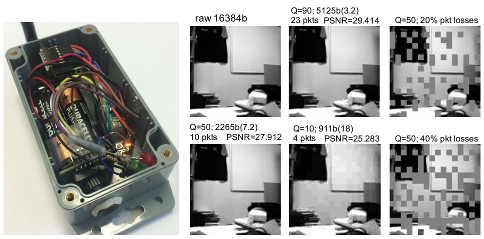

Figure 2. Long-range image sensor device

2.2 Advanced Features

Taking into account the unreliability of a clear channel assessment and the large variety of packet sizes, we propose a robust CSMA-based channel access mechanism adapted to LoRa networks to better prevent packet collision in dense deployment scenario [5].

In countries under duty-cycle regulations for LoRa transmissions, the framework also proposes an advanced radio activity-sharing mechanism allowing some devices (for instance demanding image sensors) to borrow activity time from other devices in order to globally satisfy the duty-cycle requirements [6].

2.3 Deploying Use-cases

Figure 3. Use-cases and Minimum Viable Products

The generic platform is used in WAZIUP to propose 4 Minimum Viable Product (MVP): Cattle Rustling, AGRI, Water-Fish Farming, and Waste Mgnt. Significant real-world deployment have already been realized in Senegal (Cattle Rustling, AGRI), Ghana (Fish Farming, AGRI-Weather) and Pakistan (AGRI-Soil with multi-level soil moisture for crop irrigation). The latter was done in collaboration with the Nestlé's WaterSense project.

2.4 The Versatile Gateway

Our gateway is single-channel but can also receive (and decrypt if necessary) LoRaWAN packets on DR0 channel. The gateway architecture highly decouples the low-level gateway functionalities from the high-level data post-processing features, privileging high-level languages for the latter stage, see Fig. 4. Customizing data management tasks can be done in a few minutes, using standard tools, simple REST API interfaces and available public clouds. We provide ready-to-use cloud scripts that already supports a number of publicly available IoT clouds such as `Firebase`™, `ThingSpeak`™, `freeboard`™, `GroveStream`™ & `FiWare`™ as well as MQTT brokers. The gateway can also been seen as a Node-Red node to be integrated in more complex task processing flows developed in Node-Red. The gateway can also handle offline scenarios where Internet connectivity is not available: SMS can be sent if a 2G/3G dongle is attached and received data can be locally stored in a NoSQL MongoDB database. With an embedded web server, it can also graphically display received data on a smartphone or tablet through a WiFi connection. Ultimately, the gateway can also be used as an end-computer by just attaching a keyboard and a display. All these interactions mechanisms can be selectively enabled as needed, including enabling all of them.

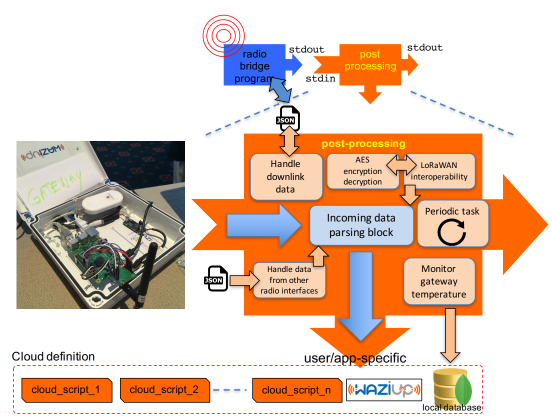

Figure 4. Modular and versatile low-cost gateway

3 References

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