Review of Continuous SME Call 2nd stage Experiment: Precision Agriculture With LoRa (PAWL)

PANGAEASA

Online Review

27/1/2022

Experiment Description

CONCEPT

- Experiments with LoRa and ZigBee
- Precision agriculture applications
- Installation of IoT agricultural nodes
- Side-by-side analysis on data transmissions, coverage and power consumption

Experiment Description

OBJECTIVES

- Install our existing ZigBee solution next to the existing LoRa nodes of the NITOS agricultural testbed.
- Conduct experiments in order to compare data rates, power consumption and coverage between ZigBee (extended range radio modules) and LoRa. The goal was to determine which one performs better in our use cases.
- Assess the cost-effectiveness of each solution based on various parameters like the number of required nodes and their costs.

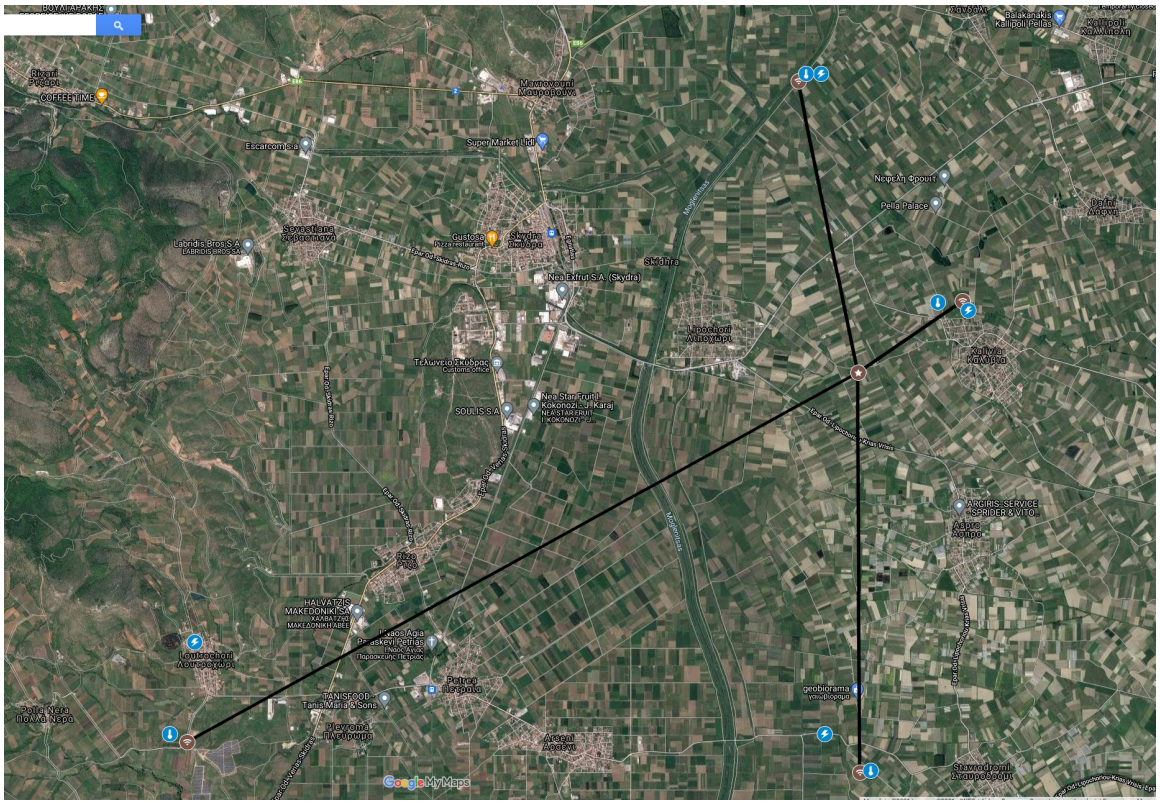
Experiment Description

BACKGROUND AND MOTIVATION

- Our company has been active in agricultural area of Thessaly in Greece, serving several farmers with tailor-made solutions for precision agriculture.
- Experiment/Consider new technologies for adoption.
- Increase cost effectiveness.
- Maintain performance and reliability.
- Experimentation in realistic environment.

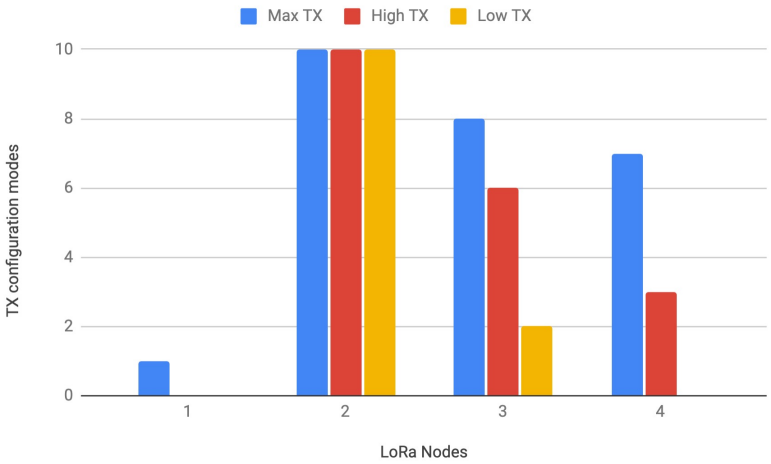
Experiment Description

NITOS AGRICULTURAL TESTBED



Project Results

MEASUREMENTS



LoRa Nodes Connectivity

Mode	BW	CR	SF	Sensitivity (dB)	Transmission time (ms) for a 100-byte packet sent	Transmission time (ms) for a 100-byte packet sent and ACK received	Comments
1	125	4/5	12	-134	4245	5781	max range, slow data rate
2	250	4/5	12	-131	2193	3287	-
3	125	4/5	10	-129	1208	2120	-
4	500	4/5	12	-128	1167	2040	-
5	250	4/5	10	-126	674	1457	-
6	500	4/5	11	-125,5	715	1499	-
7	250	4/5	9	-123	428	1145	-
8	500	4/5	9	-120	284	970	-
9	500	4/5	8	-117	220	890	-
10	500	4/5	7	-114	186	848	min range, fast data rate, minimum battery impact

SX1272 Configuration modes

Parameter	SX1272 power level
'L'	0 dBm
'H'	7 dBm
'M'	14 dBm

SX1272 Transmission power values

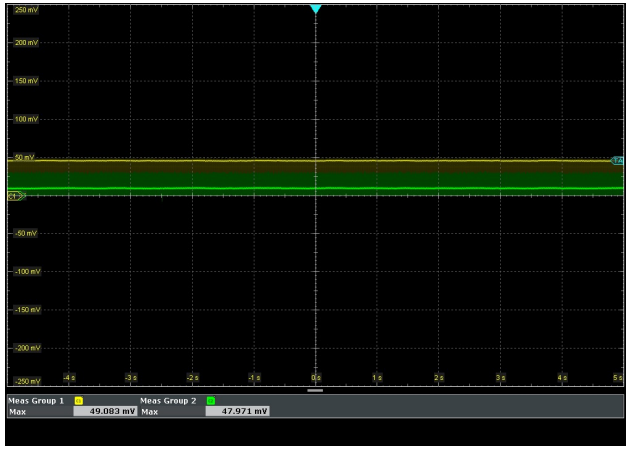
Project Results

LESSONS LEARNED

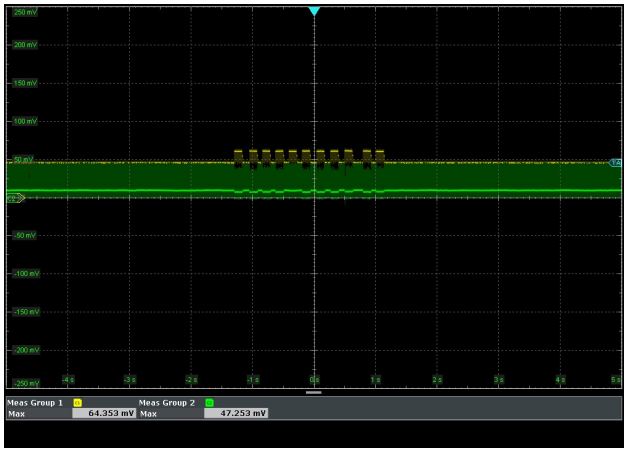
- Our Xbee radio modules could not compete to LoRa in terms of coverage, which resulted in deploying the same number of Xbee Gateways (4 in total) as the sensing nodes paired to each other.
- LoRa proves to be a more cost-effective solution compared to the Xbee solution since its extended coverage can reach up to 9km in our scenarios, while Xbee cannot cover more than 1.5km.
- Xbee could achieve data rates up to 10kbps.
- LoRa could achieve from 0.368 Kbps up to 4.304 Kbps.

Project Results

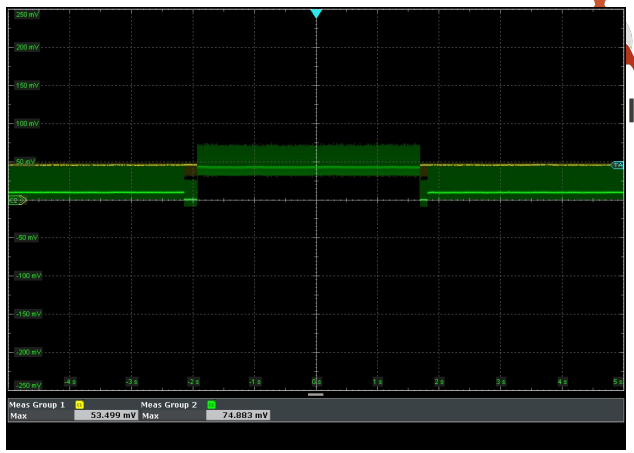
MEASUREMENTS



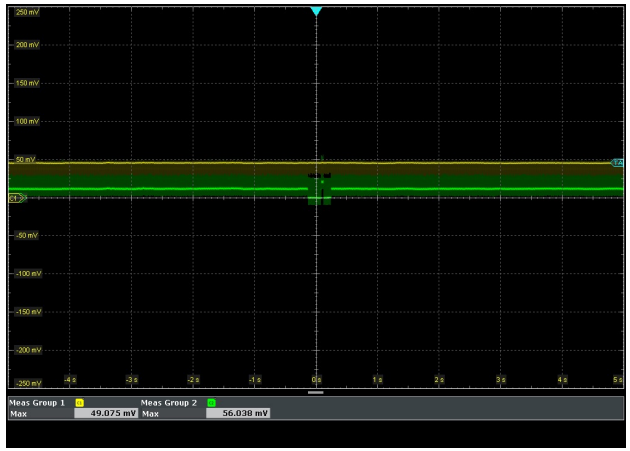
LoRa and Xbee in Receive Mode



Xbee Transmitting



LoRa TX mode 1



LoRa TX mode 10

Project Results

LESSONS LEARNED

- LoRa requires more power for greater coverage and lower data rates compared to Xbee.
- LoRa minimizes the need of additional Gateways, thus reducing the CAPEX and OPEX of a precision agricultural solution.
- LoRa can operate standalone with a battery and solar panel (Stage 1 experiments).
- LoRa radio module can be put to sleep mode.

Business Impact

- Identified advantages and disadvantages of using LoRa compared to Xbee for precision agriculture applications.
- Identified coverage limits of LoRa and Xbee modules.
- Identified the energy efficiency of each module.
- Knowledge gained through these experiments would require investment in time and money in R&D.

Business Impact

- LoRa could replace our existing Xbee solution.
- CAPEX and OPEX minimization in precision agriculture products.
- Minimization of required gateways and reuse of the existing unnecessary gateways in new locations.
- Ability to create tailor-made IoT solutions that fit better to the domain/application and its requirements in terms of throughput, coverage and power autonomy.

Business Impact

- Conduct a large-scale experiment under realistic conditions with real equipment.
- New business opportunities.
- Optimize current precision agriculture applications.
- Acquainted with Fed4FIRE+ for future R&D experiments.

Feedback

EXPERIMENT ENVIRONMENT

- In our initial plan we had allocated 1 month for deploying our own agricultural nodes and integrating them into NITOS Agricultural testbed.
- Having dedicated support through the Patron helped a lot to speed up processes and the experiment in general. It allowed us to focus on more critical components of our experiment.
- We were happy with the amount of resources and technologies provided by the different Fed4FIRE+ testbeds.
- We could evaluate LoRa transmissions in a realistic environment of agricultural fields in a reproducible way.

Feedback

ADDED VALUE OF FED4FIRE+

- We could not find any other funding opportunities that offered agricultural LoRa testbeds.
- The offering of Fed4FIRE+ enabled us to start thinking our experiment and do not worry about the deployment of LoRa nodes in realistic environment
- The diversity of available resources is possibly the most attractive characteristic of the federation as it can support a vast variety of experiments.
- Combined with the dedicated support by the testbeds, which speeds up the process of preparing and running an experiment, are the two most valuable things Fed4FIRE+ has to offer.

Feedback

WHAT IS MISSING

- Our needs were totally covered by the current tools and APIs.
- As a next step the federation or each testbed individually could think of mechanisms of orchestrating automated experiments.
- Having the testbed running your experiment for you, would have been the next level of support that someone could have expected.
- This way you focus only on describing the experiment and what you want to test to the testbed and the latter manages all the technical details for setting up and running the experiments.


Co-funded by the
European Union


Co-funded by the
Swiss Confederation

This project has received funding from the European Union's Horizon 2020 research and innovation programme, which is co-funded by the European Commission and the Swiss State Secretariat for Education, Research and Innovation, under grant agreement No 732638.

WWW.FED4FIRE.EU