Review Continuous Open Call Experiments

LoWIntEr

Matic Serc

MSc Tel. Eng., ELMIBIT CEO

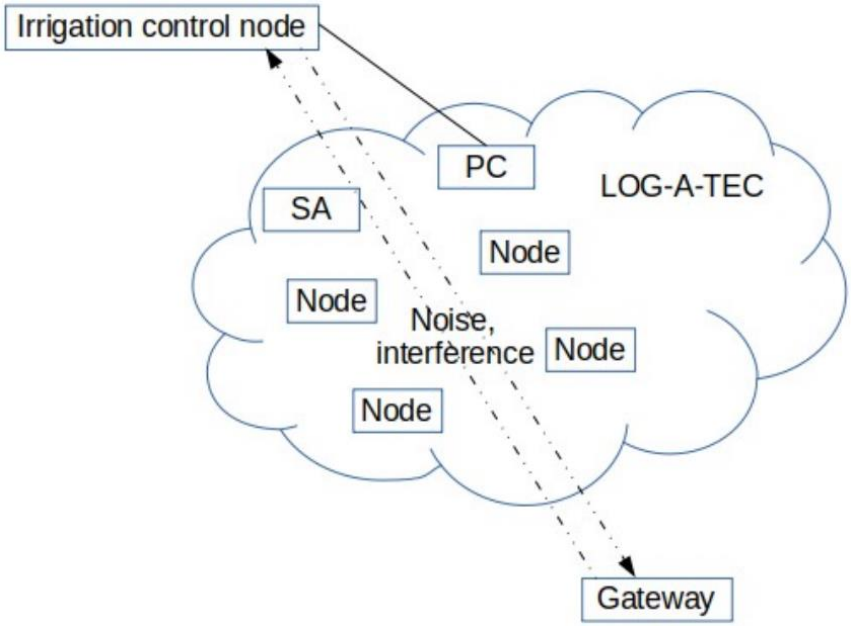
FEC8

Held Online, calling from Maribor, Slovenia

Experiment motivation

- **End-to-end (Application to Valve Controller) Irrigation Valve Control system with market-competitive pricing**
- System originally designed and proven for agricultural applications in open agricultural space in the US
- System: several low-cost, off-the-shelf components, together with proprietary devices, firmware and software
- To test system, adapted to EU frequencies and regulations, in conditions with high levels of noise and interference in order to prove applicability to "smart city" scenarios
- During experiment: research and identify space for improvement of particular system

Concept and objectives

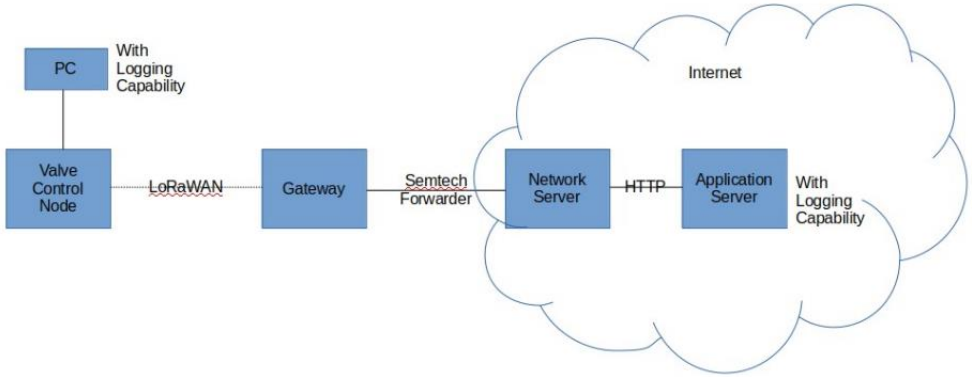


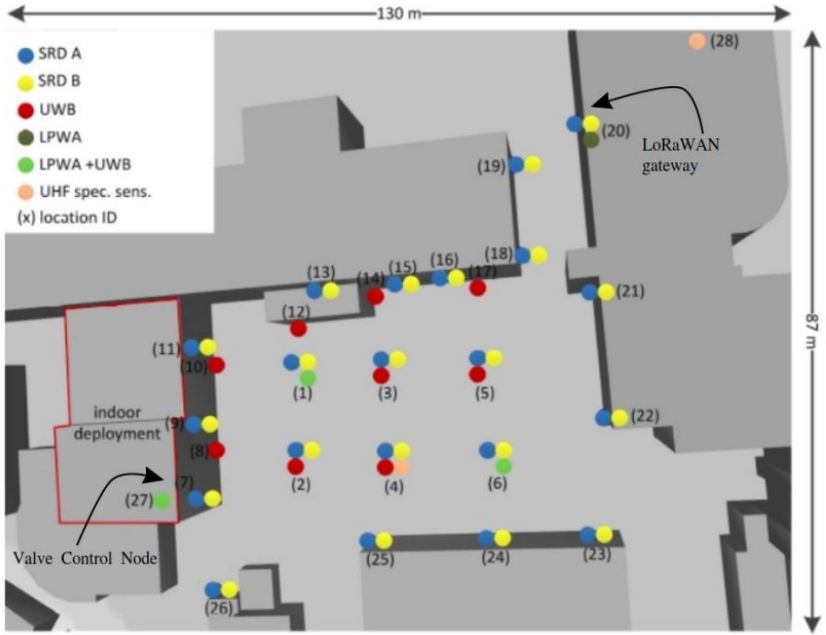
(1) find borderline level of acceptable noise and interference in which 90% of the communication will be successful in upstream direction

(2) find borderline level of acceptable noise and interference in which 90% of the communication will be successful in downstream direction

(3) verify that the transmission air-time, rate, bandwidth and emmitted power are within the standard requirements for Europe

Experiment set-up



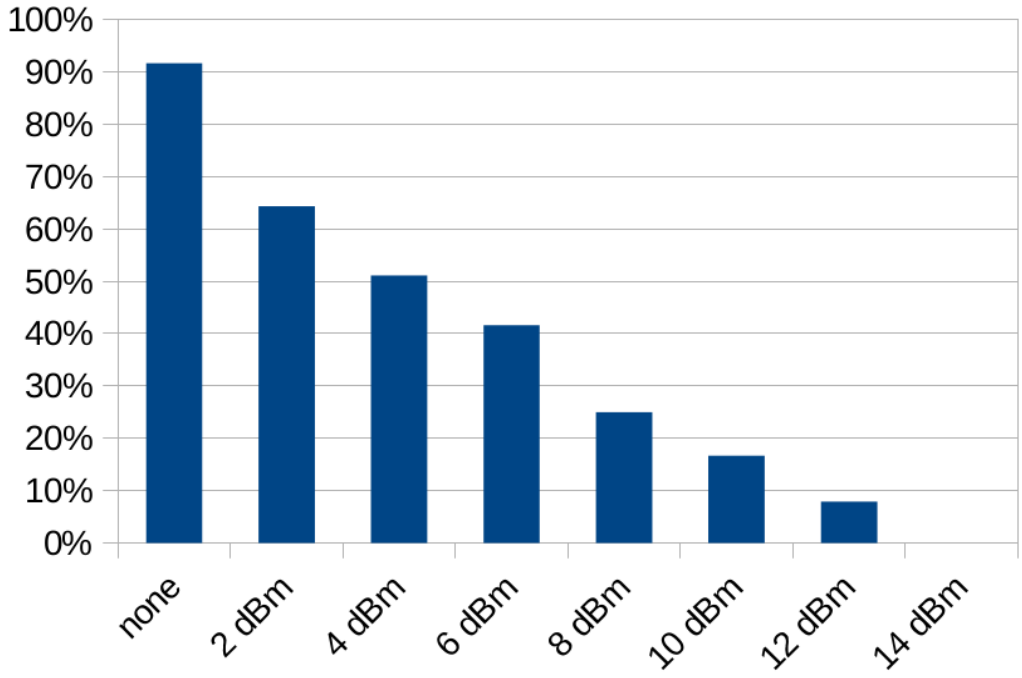


3 resilience tests

1. **Test with LoRaWAN devices generating interference:**
   1 packet per second for 14 hours
   2 dBm to 14 dBm in +2dBm increments per 2 hours

2. **Test with noise generation on single and multiple center frequencies:**
   QPRSK-SIN, data rate 250 kBit; -5 dBm to 11 dBm
   I. Central frequency 868.3 MHz; II. 865 – 879 MHz

3. **Test with 6LoWPAN communication interference:**
   21 devices, 1 packet per 30 seconds,
   1 device continuous multicast for last 2 hours

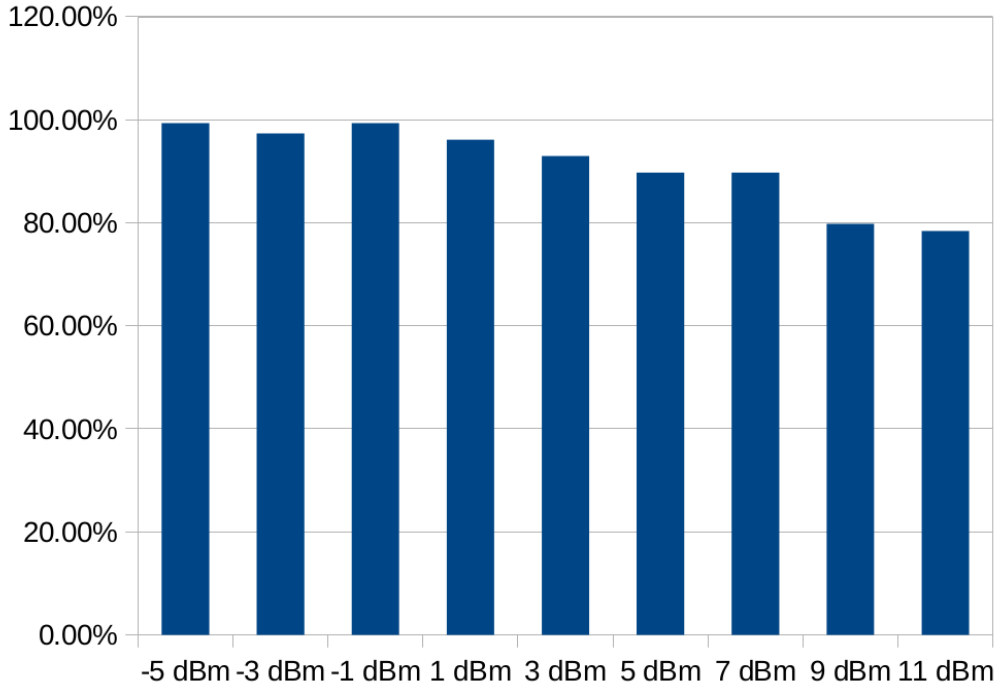


50%+ message delivery success rate up to 4 dBm

Very unlikely scenario in real-world conditions

Lesson: space for improvement in firmware design

COMBINED SYSTEM SUCCESS RESULTS, TEST 1, GENERATION OF LORAWAN INTERFERENCE

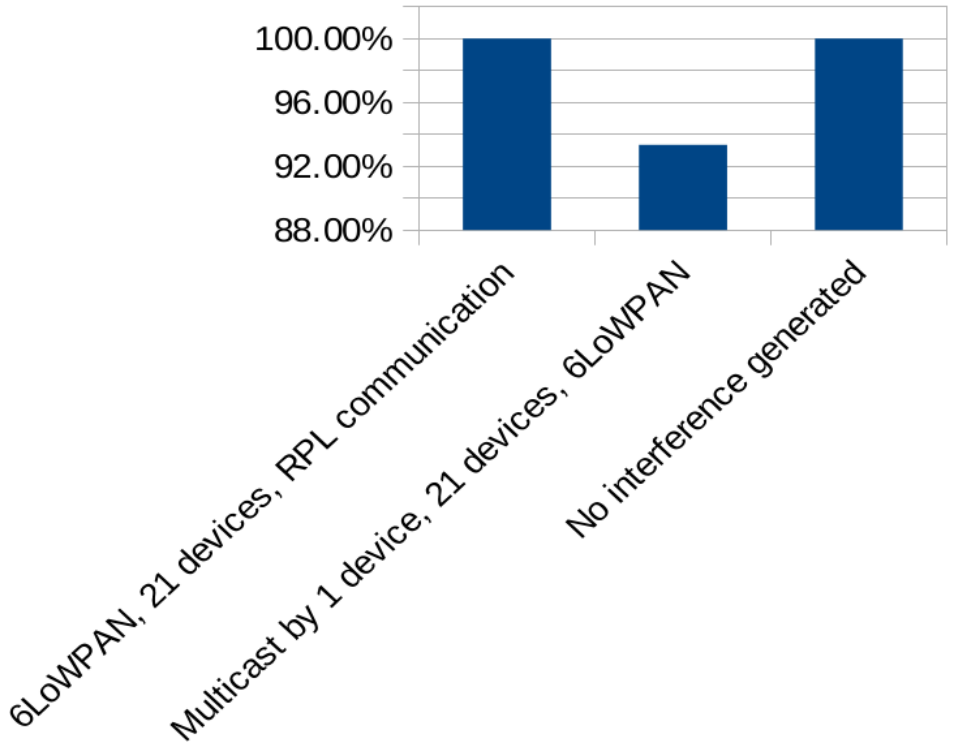


Only results when noise on multiple center frequencies

Success rate below 90% only at 9 dBm and 11 dBm

Never below 75% success rate

COMBINED SYSTEM SUCCESS RESULTS, TEST 2, GENERATION OF NOISE



Slight drop in period of time with multicasting by 1 device

Always above 90% success rate

Lesson: High system resiliency to interference

COMBINED SYSTEM SUCCESS RESULTS, TEST 2, 6LOWPAN INTERFERENCE GENERATION

Business impact – general

- Application to FED4FIRE due to:
  - Requirements:
    - Need to modify firmware of valve control component for deployments in European Union
    - Need to verify system's operation under conditions with high levels of noise and interference
  - Opportunity:
    - easy access to testbeds and covered experimentation costs
    - unified and user-friendly testbed environment usage

Business impact – market level

- Accelerated preparation of solution to address expansion to new markets:
  - Geographically: adjusted, tested and pre-verified the system for correct operation in European Union
  - Application-wise: tested and verified correct operation in environments with high levels of noise and interference, where it was not used up to this day (originally designed for agricultural purposes)

Business impact – technical level

- measured and verified performance with considerably lower cost and effort than in a combination of operational and own laboratory environment
- discovered space for improvement in firmware design for improved downlink performance
- systematically tested and avoided discovery of issues later in the first pilot deployments

Business impact – value percieved

- Confidence in introducting solution to a new market
- Time-saving in the long run due to early detection of optimization potential
- Cost-saving in the long run

FED4FIRE
Used Resources

LOG-a-TEC (JSI)	Yes	Used in total 24 LPWA and SRD-A devices over the course of 4 days for generation of different interference patterns.

Travis CI	Yes	For managing the nodes, the tool was instrumental to set up the experiment and worked for the given purpose.
Rundeck	Yes	To control access to the nodes and to leverage existing scripts, the tool allowed us fast experimentation scenarios set-up and worked for the given purpose.
Munin	Yes	For monitoring devices in the testbed, the tool allowed us to monitor the execution and worked for the given purpose.
Ansible	Yes	Playbook and Docker for executing actual experiments on the nodes.

FED4FIRE Used Tools

How did FED4FIRE help with experimentation

- Ability to use testbed in a manner that was easy to comprehend and allowed quick implementation of our project was crucial to achieving benefits in a cost-effective and time-saving manner
- Exceptional support and advice from the Testbed's team added value, as it allowed helped us gain new insights about underlying communication technology used in the tested solution
- Financial coverage of experimentation costs

"We are now confident that our solution may work in city environments reliably, while we even discovered room for improvement which would otherwise be discovered only once it was deployed in nature, saving us a lot of resources on our way to further commercialization."

Thanks to the experiment we conducted in FED4FIRE+

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.

THANK YOU FOR YOUR ATTENTION

WWW.FED4FIRE.EU