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Using Sigfox to salinity sensing in *Salicornia ramosissima* crops of Ria de Aveiro

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Motivation & *Salicornia Ramosissima*



Motivation & *Salicornia Ramosissima*



- *Salicornia ramosissima* J. Woods
- Commonly known as glasswort or sea asparagus,
- Annual plant occurring along the coastal salt marshes and saltpans (Iberian Peninsula / Medit.)
- Produces succulent, salty-flavored shoots.
- Recently, interest as gourmet food, relevance as nutritional/organoleptic and medicinal product.
- Very tolerant to high salinity
- Seedlings and biomass production significantly dependent on the fluctuations of sediment salinity.

Motivation & *Salicornia Ramosissima*



- Ria de Aveiro: a shallow lagoon, in the Northwestern Portuguese coast
- Salt produced by evaporation in saltpan areas but not economically viable (just touristic activities).
- Abandoned saltpans, sea water level rise led to damage to the lagoon (destruction of walls, ...).
- Salicornia seems to be a good alternative due to commercial value and adequacy of the lagoon.
- Some farms already: Horta dos Peixinhos, Ilha dos Puxadoiros (AmiEs 2014 social activity).

Motivation & *Salicornia Ramosissima*



Motivation & *Salicornia Ramosissima*



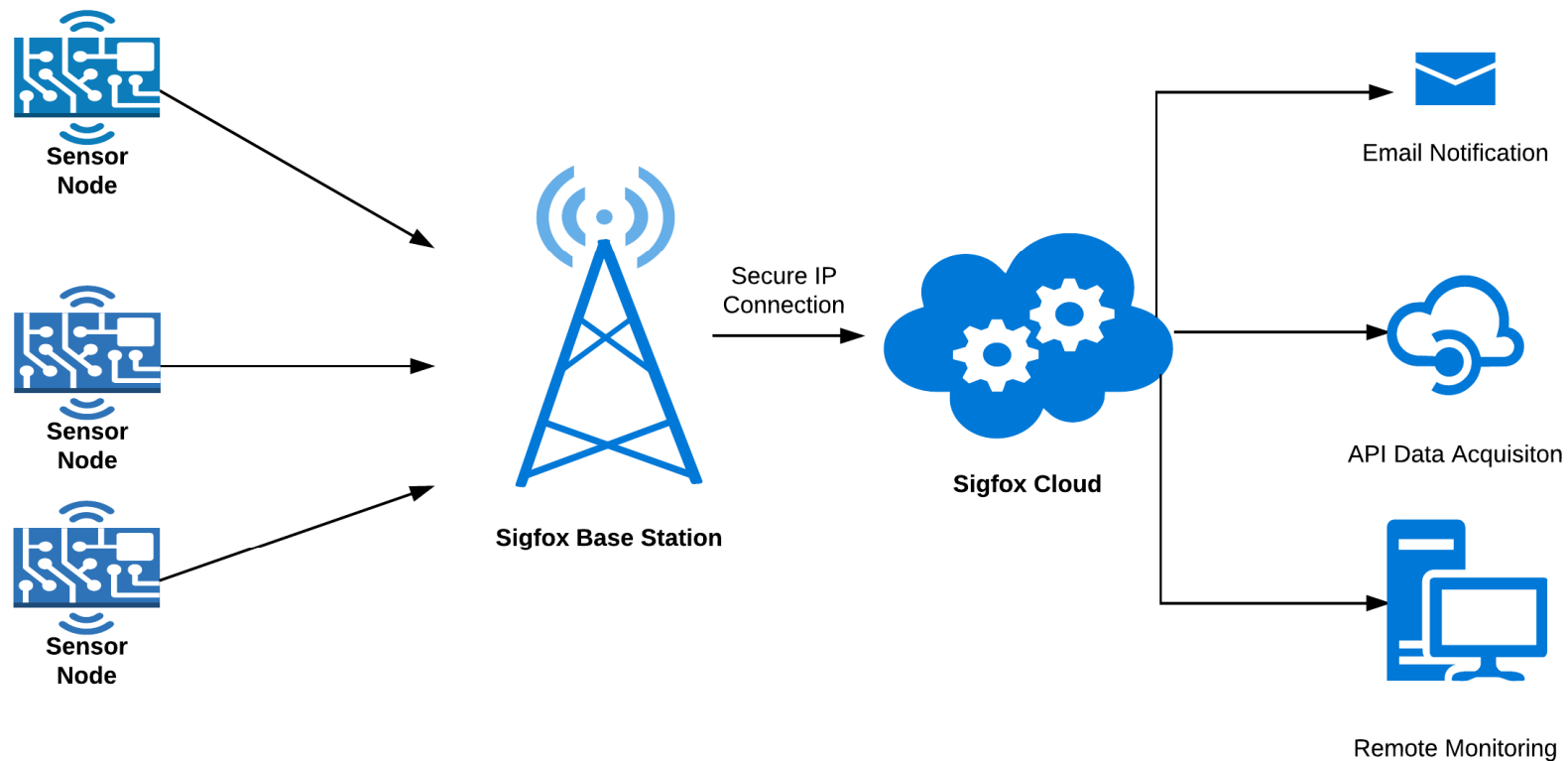
- The problem to solve:
 - How to control the level of salinity in the soil.
- What kind of infrastructures:
 - Salinity sensors.
 - Other sensors: water level, turbidity, absorption, density, solved oxygen, pollution (hydrocarburates in the water).
 - Control of salted water admission valves.
 - Control of rain water deposits to compensate excessive salinity.
 - Detection of flooding in the saltpan.
- Additional issues:
 - Electrical power.
 - Local prone to intrusion with stealing of goods.

A brief description of Sigfox®



- Sigfox is operating in Portugal since 2 to 3 years through Narrownet.
- Falls in the category of LTNs – Low Throughput Networks.
- Characteristics making it adequate for this application:
 - Low price of the transceivers and of the transmission.
 - Claimed range and coverage.
 - Very low energy consumption due to the used protocol.
 - Adequate for a reduced payload and a few frames per day.
 - Easy integration with IoT platforms.
 - One tiered network – avoids user gateways (e.g. as in LoRa).
 - Experience in its usage by Micro I/O in smartparking.

A brief description of Sigfox®



A brief description of Sigfox®



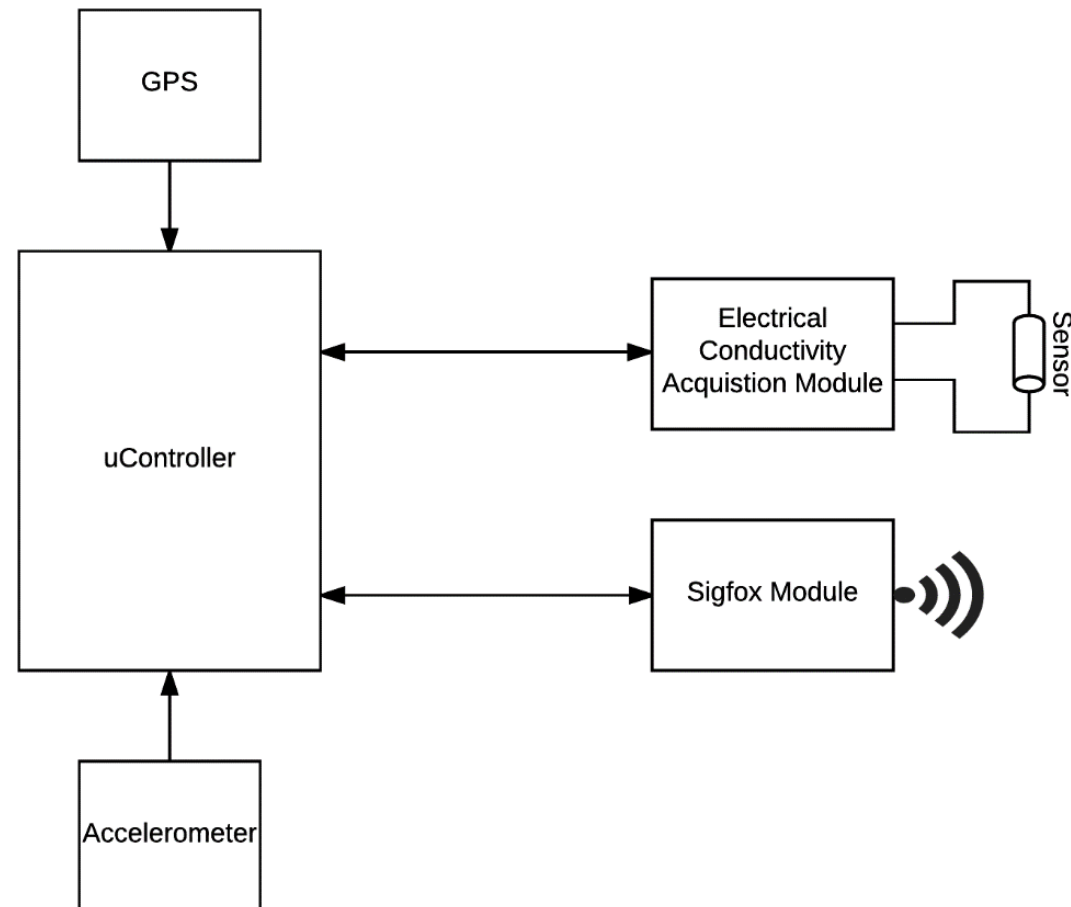
- Sigfox uses UNB – Ultra Narrow-Band communications.
- Adopts a solution with spatial and temporal diversity.
- A Sigfox transceiver transmits 3 frames in different frequencies and in different times, without any acknowledge or any channel sensing (very low energy usage).
- All base stations are listening to the spectrum used by Sigfox extracting all frames.
- The probability that one of the transmissions is listened by at least one base station is extremely high.
- Each frame of Sigfox has just 12 bytes available for user payload and there is a limit of 140 frames per day (business model).

Architecture of saltpan technology



- We use independent sensor modules each with their own SIGFOX transceivers.
- For actuator modules used in valves and pumps it was not yet decided if Sigfox will be used or not (downlink in Sigfox is not very friendly – it is only possible after a module uplink tx).
- Sensor modules use GPS so their position is always known:
 - It enables plug & play, associating the modules to the saltpan.
 - It promotes security as it is possible to detect if the nodes are being removed, GPS being activated by an accelerometer.
- Data retrieval and actuation is done by using web services from a web based platform which communicates with the Sigfox cloud.

Architecture of saltpan technology



Architecture of saltpan technology



Architecture of saltpan technology

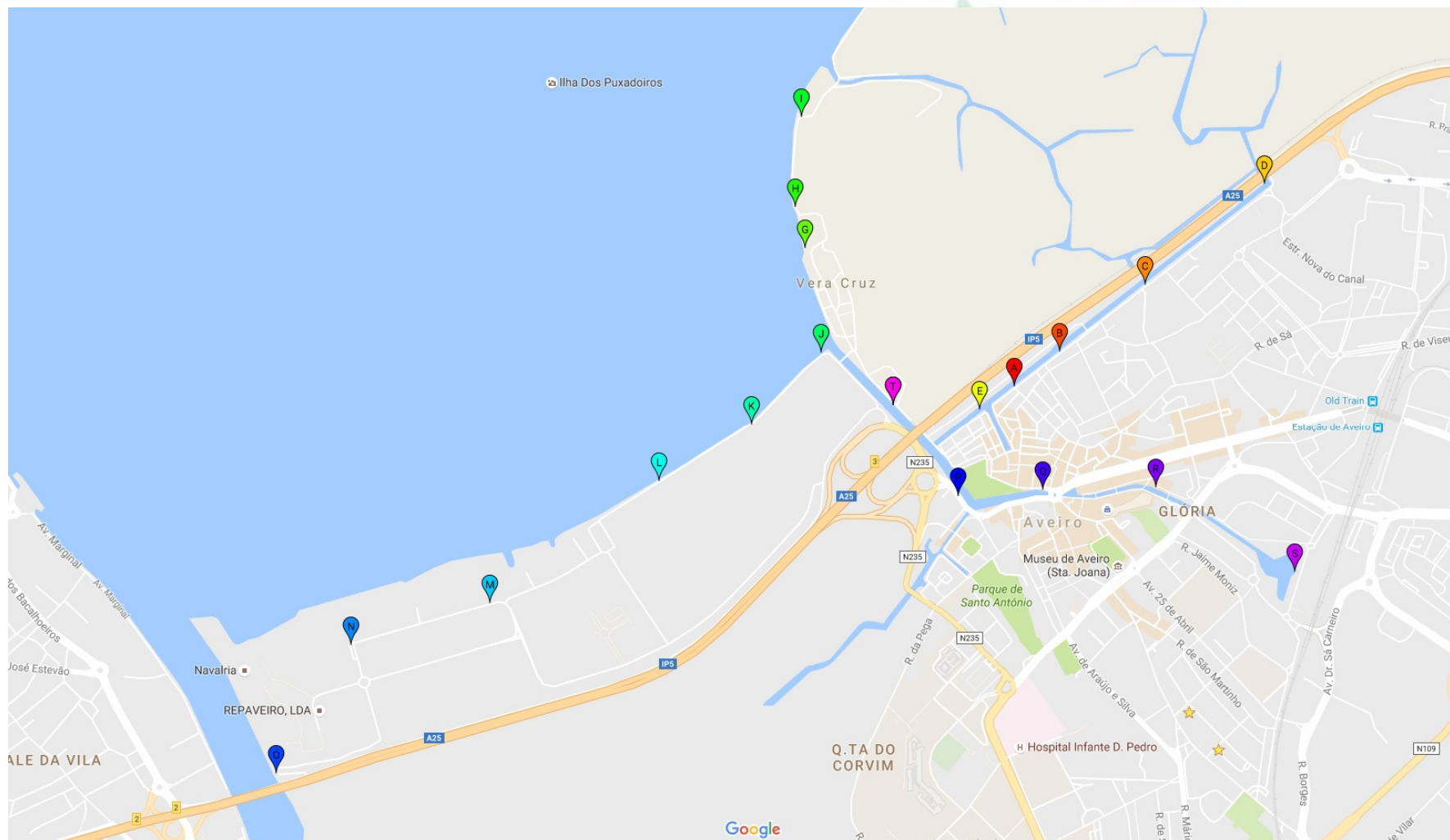


Evaluating SIGFOX coverage



- Tests performed in the surrounding area of the Aveiro lagoon,
- Around zones for possible Salicornia saltpan areas.
- For each of the points in the map, a battery of tests was performed on the 23rd and the 24th of August 2016.
- The module shown was used with an unipolar antenna.
- In each test and in each point, 10 frames with an 11 bytes payload were sent with a periodicity of 1 minute.

Evaluating SIGFOX coverage



Evaluating SIGFOX coverage



SIGFOX DEVICE DEVICE TYPE USER GROUP BILLING

Information Location Messages Events Statistics Event Configuration

Device F32CF - Messages [Purge all messages](#)

[Reset](#) [Filter](#)

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Time	Delay (s)	Header	Data / Decoding	Location	Base station	RSSI (dBm)	SNR (dB)	Freq (MHz)	Rep	Callbacks
2016-08-31 17:42:49	2.5	0000	3f1892a03461df00198007	📶	0EA0	-131.00	17.93	868.1167	3	📶
2016-08-31 16:08:12	1.5	0000	3f18886034620cc0198006	📶	0EA0	-140.00	17.93	868.1226	1	📶
2016-08-31 15:43:41	< 1	0000	3f188d703461d200198007	📶	0EA0	-134.00	15.85	868.1604	2	📶

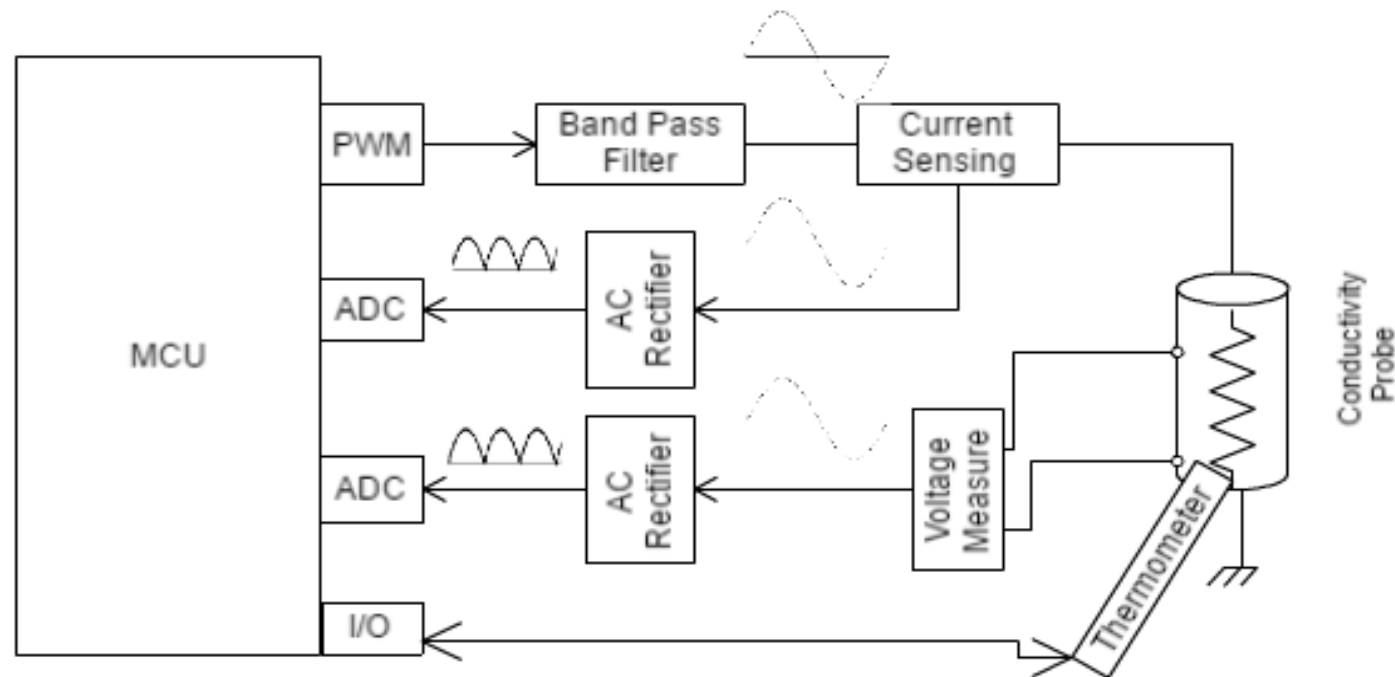
Evaluating SIGFOX coverage



Location	Sinal Quality	SNR db	RSSI dbm
A	Reasonable	15.83	-134
B	Reasonable	17.91	-129
C	Reasonable	19.23	-126
D	Reasonable	18.52	-127
E	Reasonable	14.31	-134
F	Reasonable	14.66	-134
G	Very Good	31.09	-122
H	Very Good	30.20	-123
I	Very Good	35.43	-116
J	Good	25.43	-126
K	Reasonable	17.19	-130
L	Good	26.78	-124
M	Reasonable	18.41	-131
N	Good	25.12	-126
O	Reasonable	19.77	-129
P	Reasonable	15.74	-134
Q	Reasonable	17.09	-131
R	Good	22.35	-129
S	Good	28.22	-123

Table I – Sigfox signal values for the points in the map.

On-Going Work in Sensors



- P. Ramos, J. M. Pereira, H. Ramos, A. Ribeiro, "A Four-Terminal Water-Quality-Monitoring Conductivity Sensor", IEEE Transactions on Instrumentation and Measurement, vol. 57, no. 3, march 2008.

Conclusions



- Salicornia is a promising plant to grow in Ria de Aveiro.
- It requires a reasonably tight salinity control of the soil.
- An IoT communications solution, Sigfox, can be adequate due to range, power consumption and simplicity.
- The coverage in the potential area was found to be adequate to monitor Salicornia saltpans.
- Salinity sensor requires, however, some future work.
- For this 2016/17 academic year we have 3 MSc students working on the topic including sensors, control and the web based platform.