LIVESTOCK LOW POWER MONITORING SYSTEM

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MOTIVATION

Identification

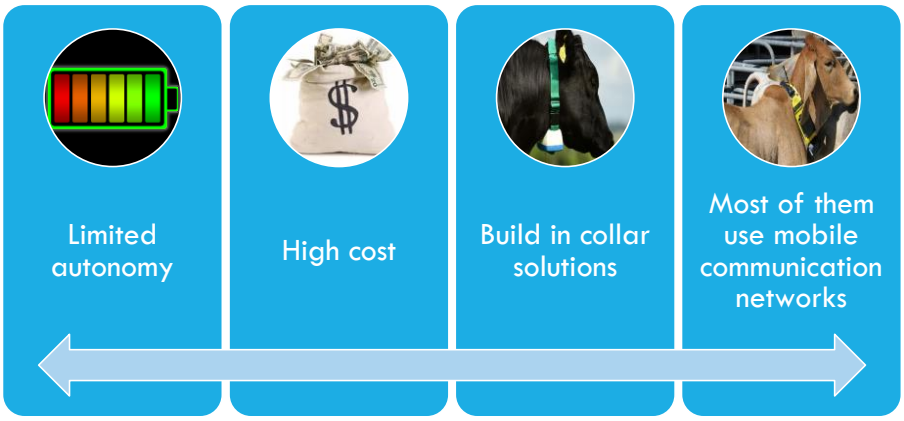
Theft of livestock

Location of livestock

MOTIVATION

- Battery duration for months and some times years.
- Sensor should be embedded into the animal in order to support harsh environments.

EXISTING SOLUTIONS



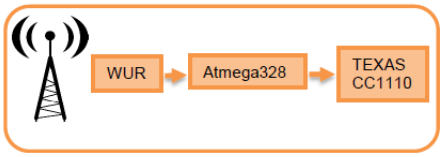
MAIN DIFICULTIES

Proposed low power radio transceiver

- Theoretical current consumption- 0.3µA
- Real current consumption- 0.134mA

2 years maximum autonomy

Solution: use a



SYSTEM ARCHITECTURE

Drone / Base Station

Low Power – Low Bit Rate Radio Transceiver

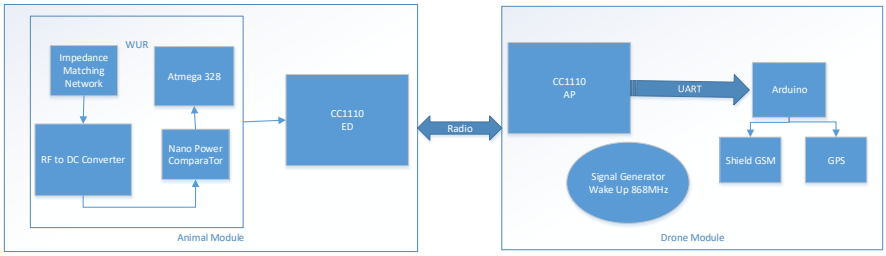
Backbone Communication (Mobile or proprietary)

LiveStock

Low Power – Low Bit Rate Radio Transceiver

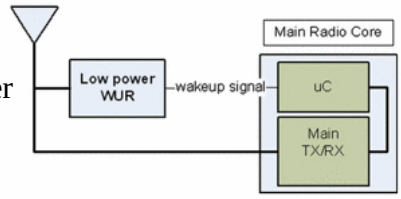
Wakeup Radio

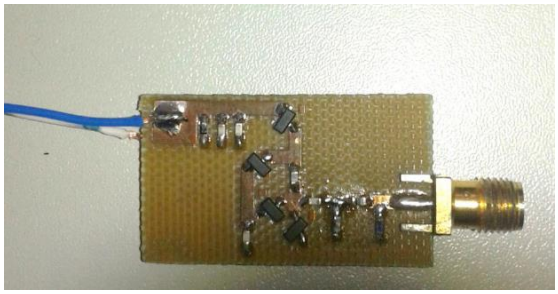
SYSTEM ARCHITECTURE



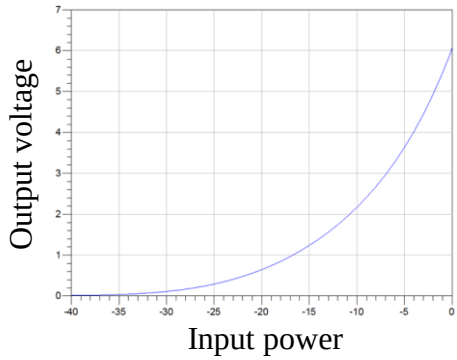
LIVESTOCK SENSOR

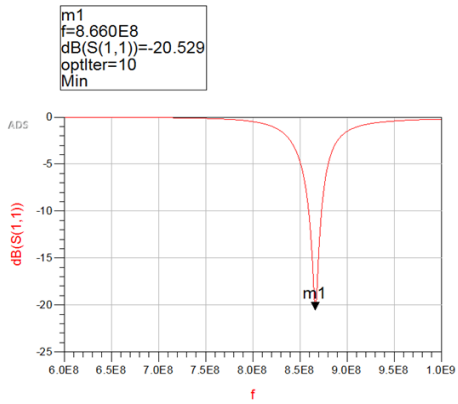
WUR based on a RF-DC converter



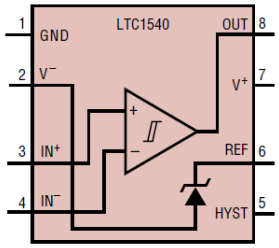


WUR - RF TO DC CONVERTER



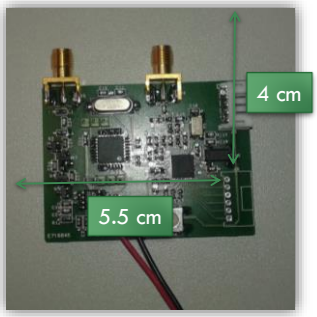


WUR – COMPARATOR AND PROCESSOR



The selected processor was ATMEGA 328, which consumes 0.02µA in standby.
Comparator consumes 1.26µA in standby and 4.21µA when operating

LIVESTOCK SENSOR



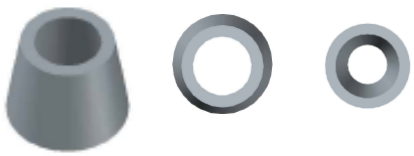
Two antenna entries, one for the WUR and another one for the transmission system

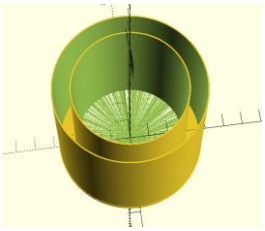
LIVESTOCK INTEGRATION

Accommodate the sensor around the horns of the cow

LIVESTOCK INTEGRATION

PLA with 100% density - $\varepsilon_r = 2.2$.

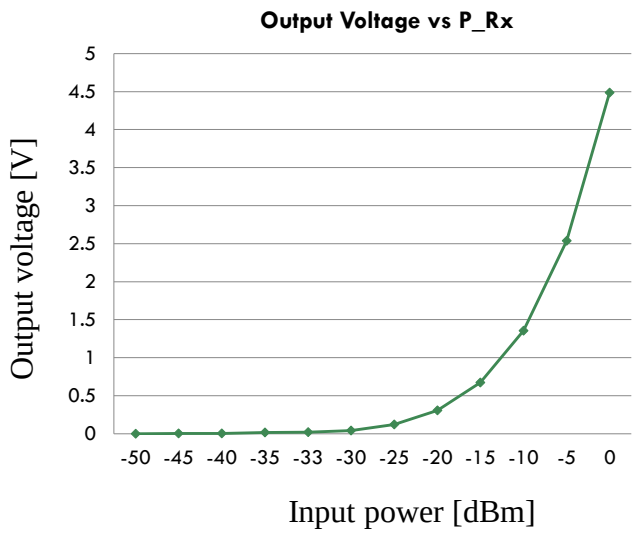




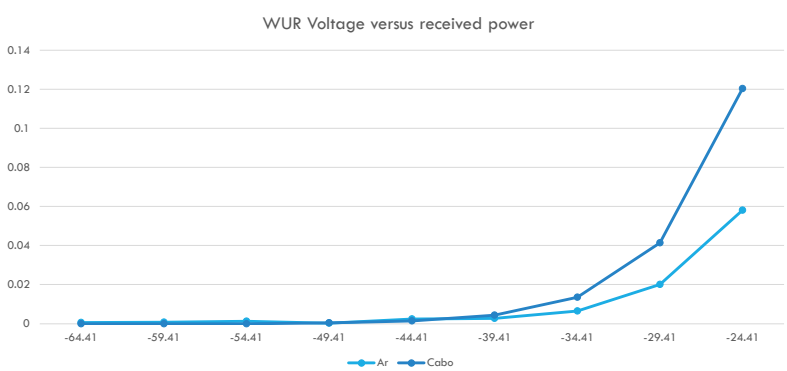
LIVESTOCK INTEGRATION

$\varepsilon_r = 47.7769$
$tan\delta = 0.3698$

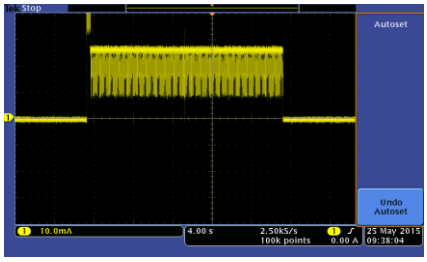
LAB MEASURED RESULTS



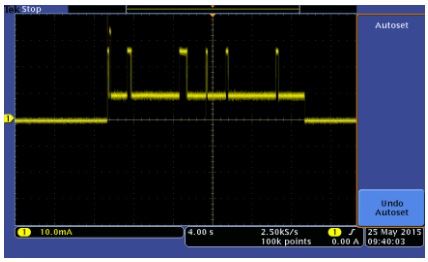
FIELD MEASUREMENT RESULTS



CURRENT PATTERN



Conection current partern when conecting to the drone AP



Conection current partern connected to the drone AP

$$I_{On} = 0.28 \times 28mA + 0.72 \times 10mA = 15mA$$

ENERGY BUDGET

$IIsleep$= 1.40µA

$IIOn$= 0.28×28mA + 0.72×10mA IOn= 15mA

$CCbat$= 2400mAh

$TTon$= 10 seconds

$TTstandby$=6∗60∗60−10 seconds = 21590 seconds

$TTCycle$=Ton+$Tstandby$

$TTCycle$=10+21590=21600 seconds

$DDon$= $TonTCycle$ Don= 1021600= 4.6296e−004

TT=$Cbat$(IOn×Don+$Isleep$(1−Don))

TT=28700 $horas$=11958 $dias$=32.76 Years

TT = T×0.8=32.76×0.8≈26 Years.

DRONE SYSTEM

Low power Radio
GPS
GSM backbone

- Drone Module made using COTS system

CONCLUSIONS

- Solution is viable for livestock monitoring
- Battery life is reasonable for the expected lifetime of a cow
- WUR is fundamental for increasing battery life

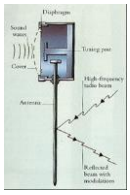
HISTORY OF BACKSCATTER RADIO

The Great Embassy Seal Bug

- Given as “gift” to US by USSR in 1946;
- Passive transduction of sound, interrogated from across

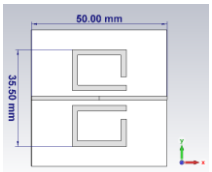
the street in the Soviet Embassy;

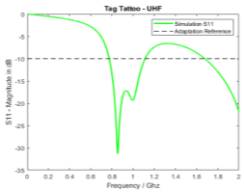
- Undiscovered until 1952;

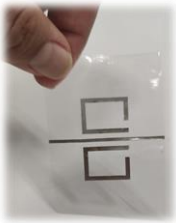


- Invented by Leon Theremin;
- Vibrating diaphragm changes capacitive load seen by antenna;
- Analog speech modulates the backscattered information;
- Reflected signal looks like small-carrier AM;

CHIPLESS TEMPERATURE MEASURING WITH BACKSCATTER







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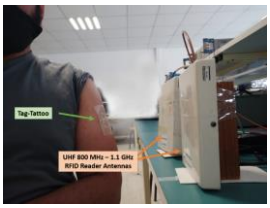

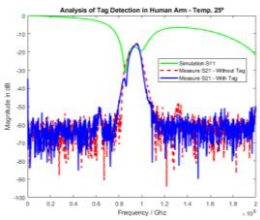

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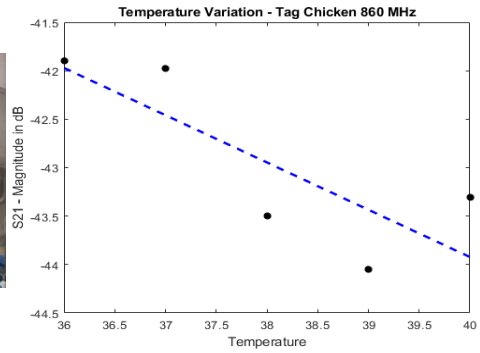

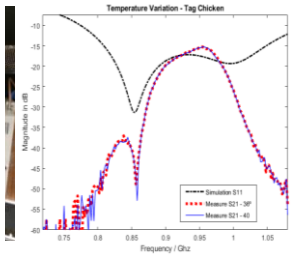

QUESTIONS?

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