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Animal monitoring based on IoT technologies

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Outline

1. Motivation
2. Overall Architecture
3. Animal Behaviour Monitoring
   - ML use case – detecting sheep's posture
4. Conclusion and future work

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Motivation

- Continuous growth of weeds needs to be controlled
- Traditional methods include:
  - Mechanical machinery
  - Chemical herbicides

- However, they are:
  - Onerous
  - Environmentally aggressive
  - Hard-working
  - Needs to be repeated through all the year

Motivation

So, how to remove vegetable species growing in vineyards and other farmlands without using expensive and aggressive mechanical or/and chemical methods?

Motivation

So, how to remove vegetable species growing in vineyards and other farmlands without using expensive and aggressive mechanical or/and chemical methods?

Using animals, specially ovines!!

Motivation

- An ancient method
- Advantages:
  - Reduction of environmental impact
  - Provision of land fertilization
  - Enhancement of the production
- Disadvantages
  - Cannot be used all the year to protect cultures
  - Need a automatized mechanism of animal handling

Solution?

SheepIT (www.av.it.pt/sheepit)

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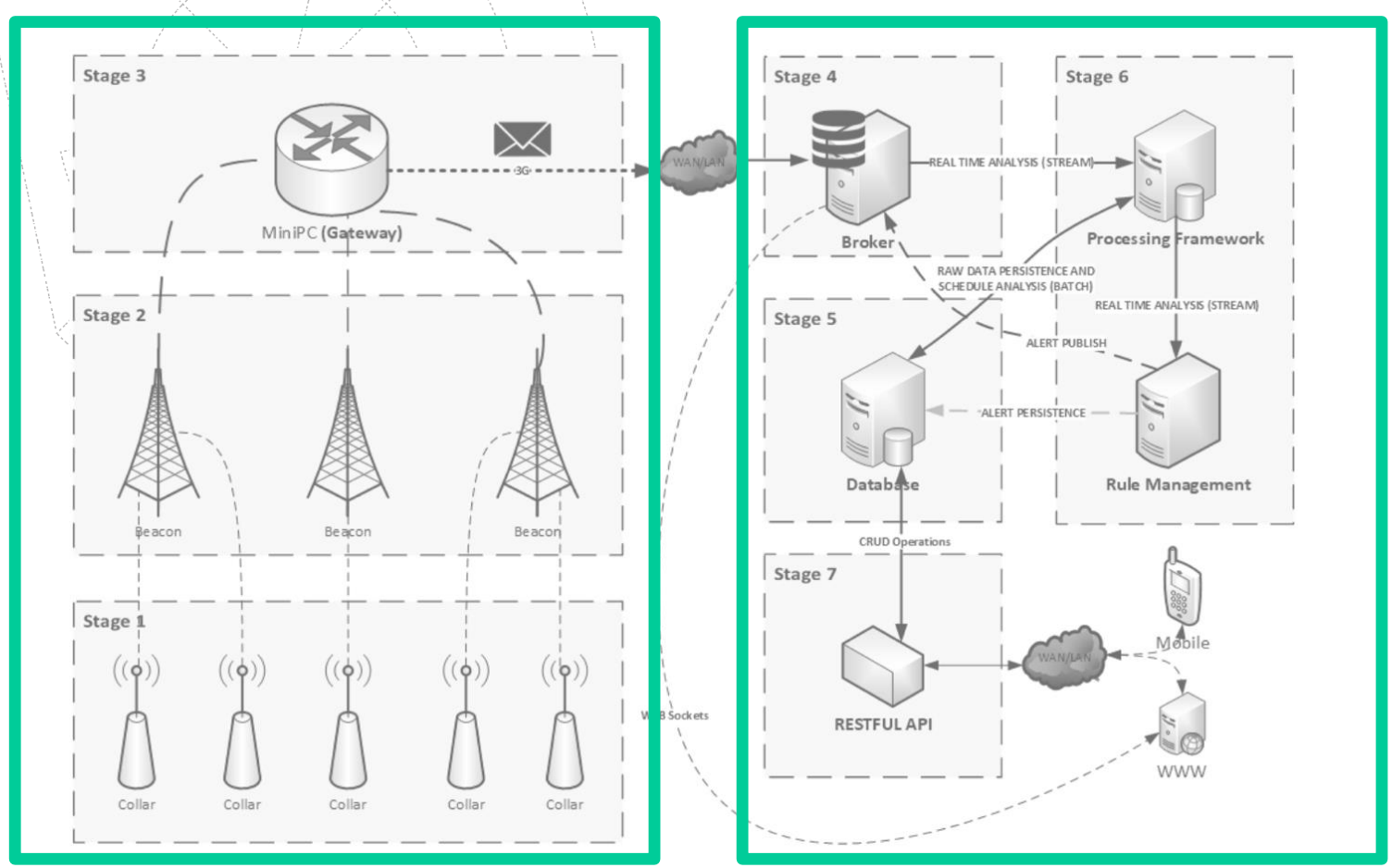
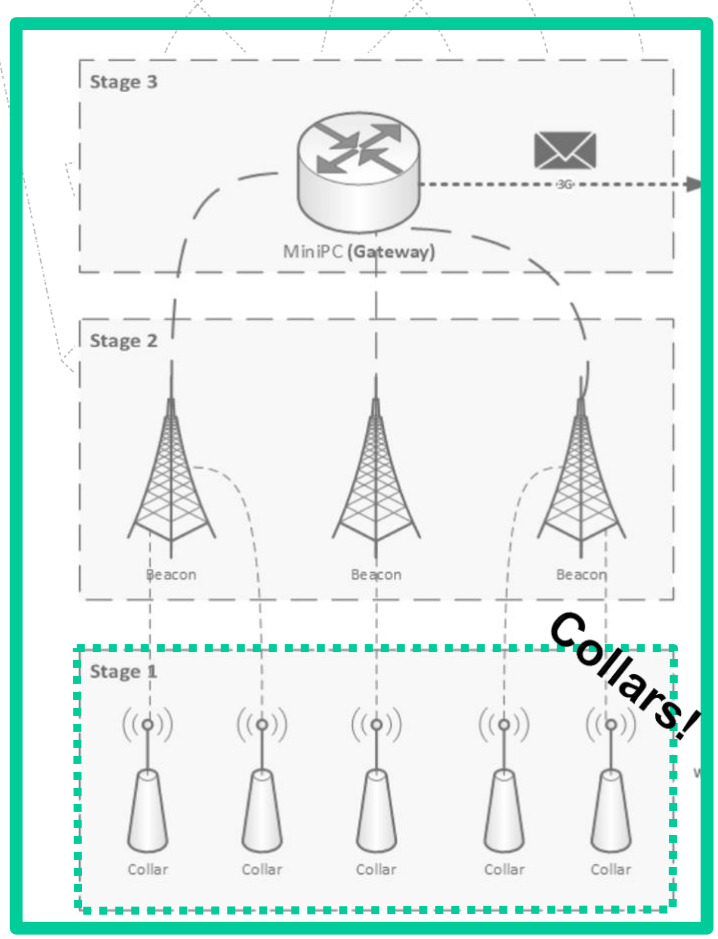
SheepIT IoT Overall Architecture



IoT local network

Cloud platform

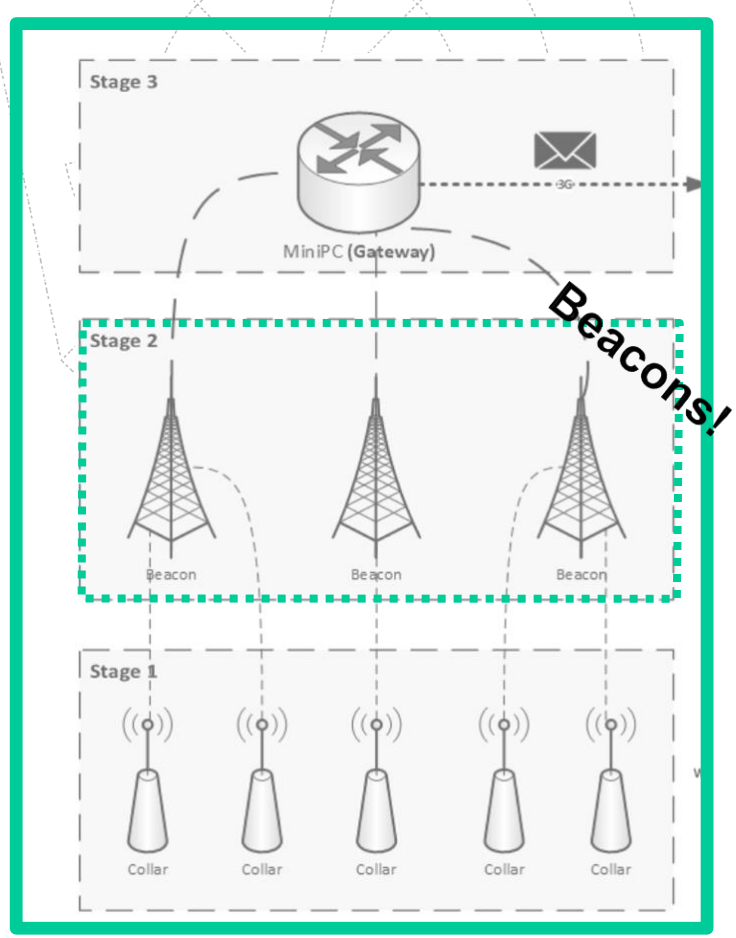
SheepIT IoT local network



IoT local network

- Collars are carried by sheep and sense animal's behaviour
- Integrated sensors:
  - Accelerometer
  - Magnetometer
  - Ultrasounds transceiver
- Integrated actuators
  - Buzzer
  - Electrostatic stimulation circuit
- Use sporadic communications to enter in the network
- Send periodic sensed data to beacons

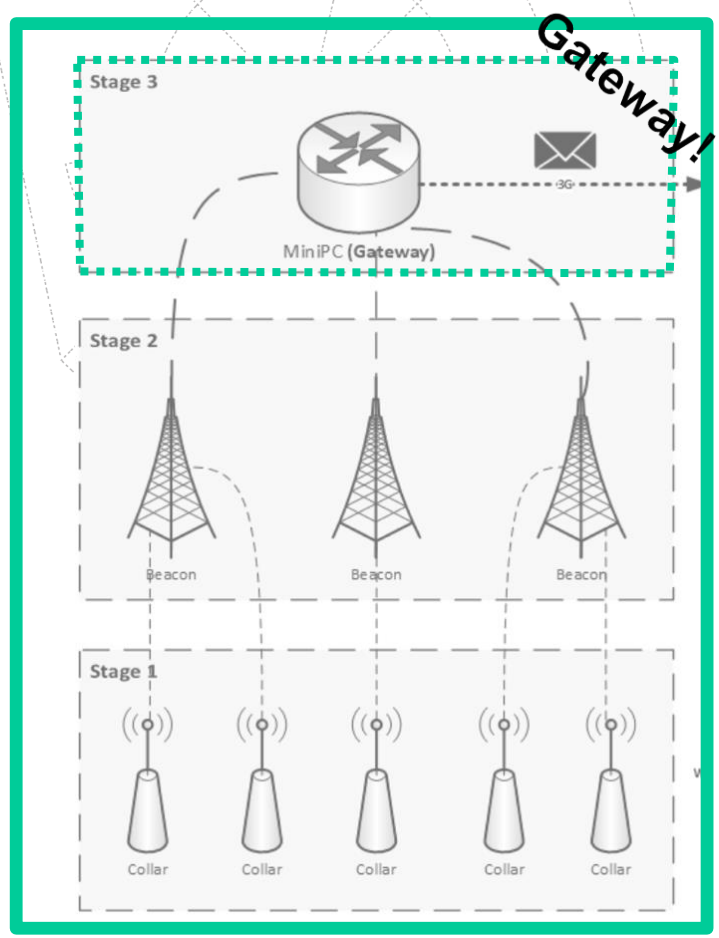
SheepIT IoT local network



IoT local network

- Beacons are installed in the intended grazing areas
- Send periodic data to collars to:
  - Collar's synchronization
  - Virtual Fence implementation
  - RSSI-based localization
- Exchange periodic data with remaining beacons
  - Relay of collar's data
  - Relay of protocol data

SheepIT IoT local network

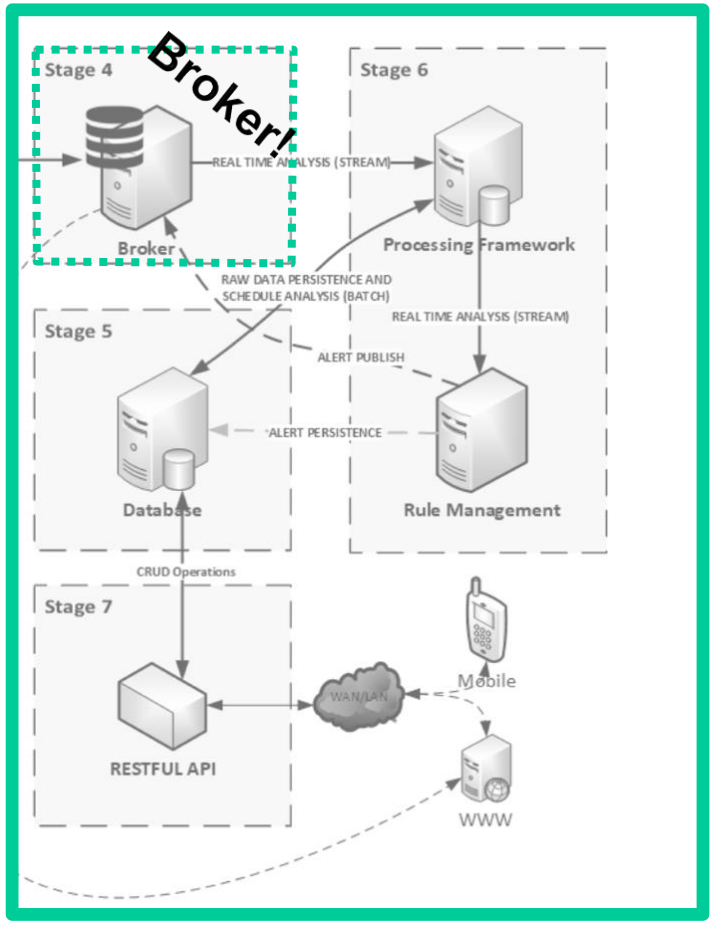


IoT local network

- Gateway is an aggregation element
- Powerful version of a beacon. Integrates:
  - A standard beacon +
  - WPAN connection +
  - Greater processing power
- Additional functions:
  - Message transportation
  - Network Manager
  - Alarm generator
- Enables the integration between non-IP network and IP-based network

SheepIT IoT cloud platform

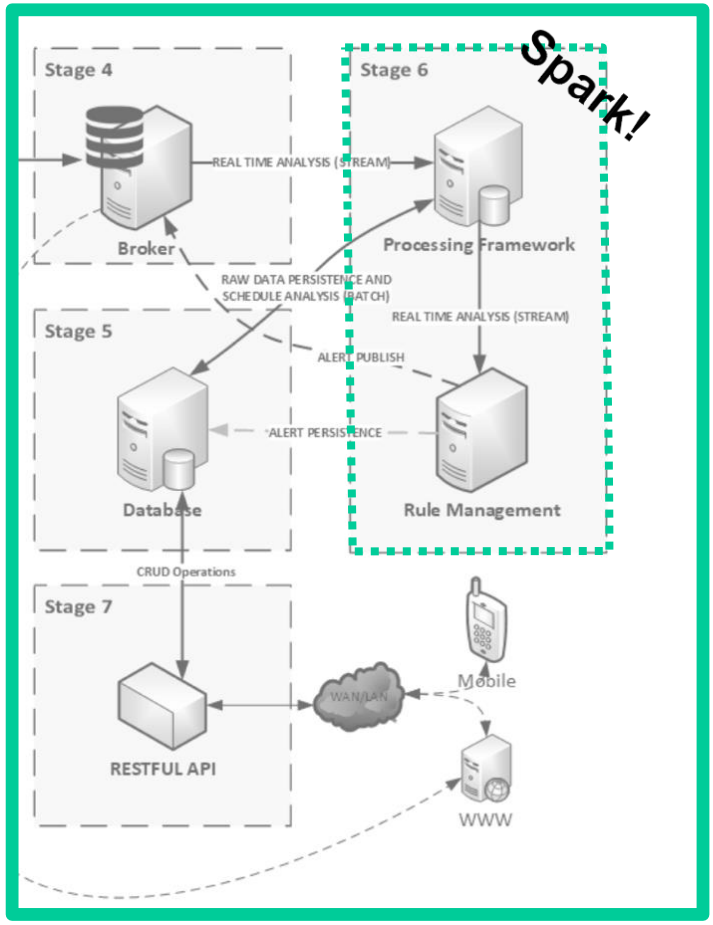
- Message Oriented Middleware (RabbitMQ)
- Receives JSON messages from the Gateway
- Supports AMQP and MQTT
- Based on Asynchronous publish /subscribe
- Implements a FIFO queue
- Implements security SSL/TLS



Cloud platform

SheepIT IoT cloud platform

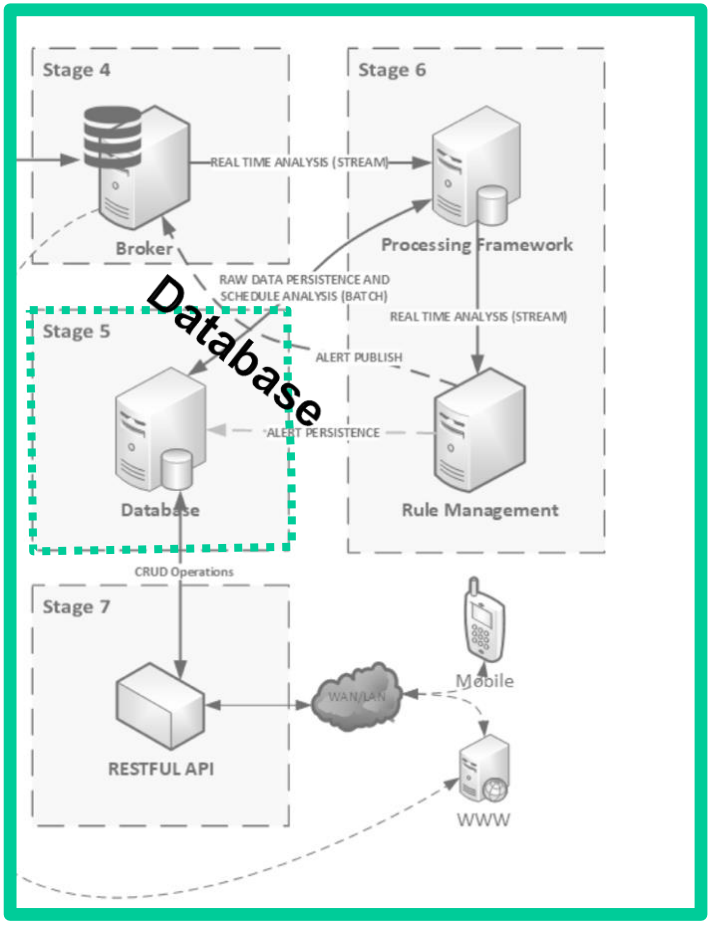
- Subscriber of the RabbitMQ
- Orchestrates all the operation inside the platform
  - JSON data translation
  - Alarms generation
  - Data processing (including ML)
  - Data persistence
- Stream process »» real-time analysis
- Batch process »» non-period analysis



Cloud platform

SheepIT IoT cloud platform

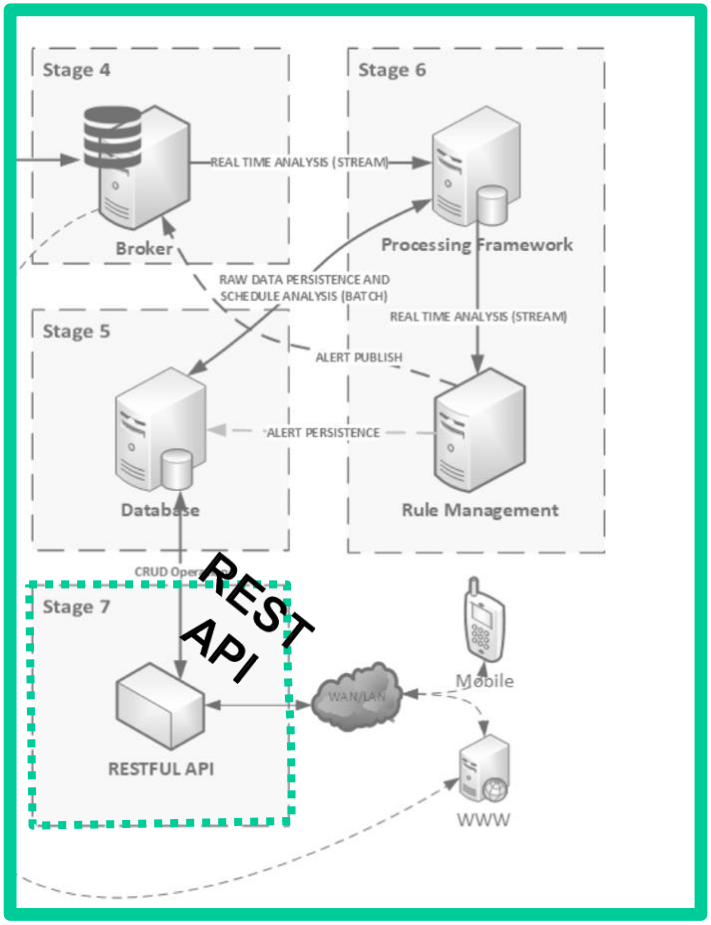
- Storage of the data from:
  - Stream process
  - Batch process
- PostgreSQL



Cloud platform

SheepIT IoT cloud platform

- Storage of the data from:
  - Stream process
  - Batch process
- PostgreSQL
- API framework to allow WEB development
- Interaction with upper layer applications



Cloud platform

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Animal behaviour monitoring

- Collars gather several data from sensors. They allow to monitor sheep's ..
  - .. posture
  - .. location
  - .. Infractions
  - .. Hours of activity
  - .. Travel times
  - .. Preferred pasture areas
  - .. Timings
  - .. Anomalous situations (panic, illness)
  - ....
- However, retrieve these information is not straightforward
- DM and ML techniques have a great potential to help solving these issues

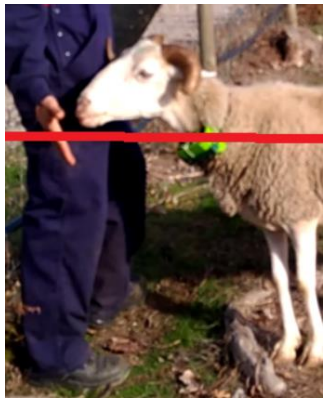
ML use case – detecting sheep's posture infractions

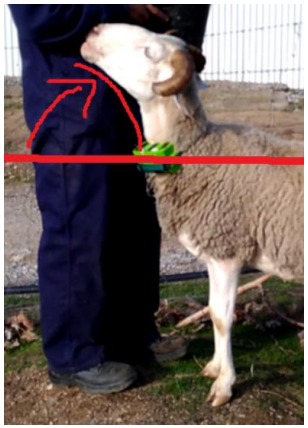
- Supervised learning algorithms to evaluate sheep's posture
- Attributes:
  - 3-axis accelerometer »» neck's tilt
  - Ultrasounds transceiver »» distance to the ground

- 3 hours of monitoring activity
- Timestamped Data recorded in a file for posterior classification
- Timestamped Video recorded

ML use case – detecting sheep's posture infractions

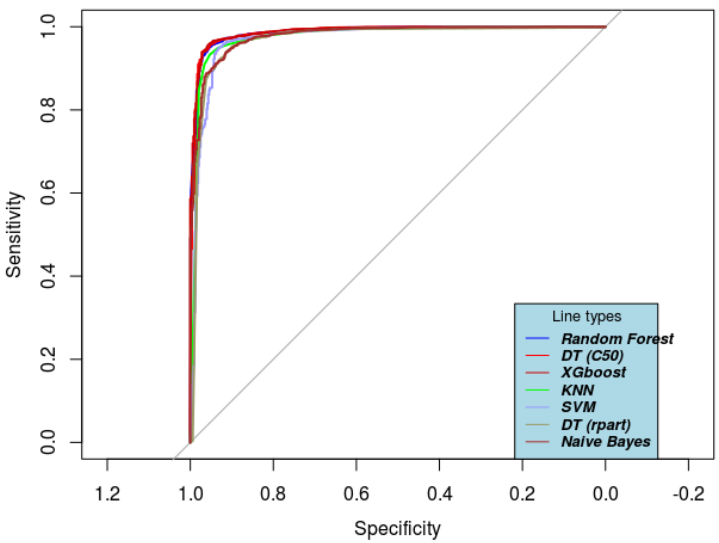
- Dataset
  - 20555 entries
  - 75% for training
  - 25% for testing
- Manual classification:
  - Resting >> NOT INFRACTION
  - Eating from the ground >> NOT INFRACTION
  - Standing reaching for food >> **INFRACTION**
  - Walking >> NOT INFRACTION
  - Running >> NOT INFRACTION





ML use case – detecting sheep's posture infractions

Algorithm	Metric				
	ACC	TPR	TNR	PPV	AUC
Random Forest	0.9696	0.8267	0.9861	0.8728	0.987
DT (C50)	0.9693	0.8475	0.9833	0.8539	0.986
XGBoost	0.9685	0.82674	0.9848	0.8625	0.988
KNN	0.9622	0.7702	0.9844	0.85.03	0.977
SVM	0.9642	0.7590	0.9879	0.8778	0.972
DT (rpart)	0.9591	0.8211	0.9750	0.8728	0.970
Naïve Bayes	0.9527	0.8795	0.9612	0.7230	0.979



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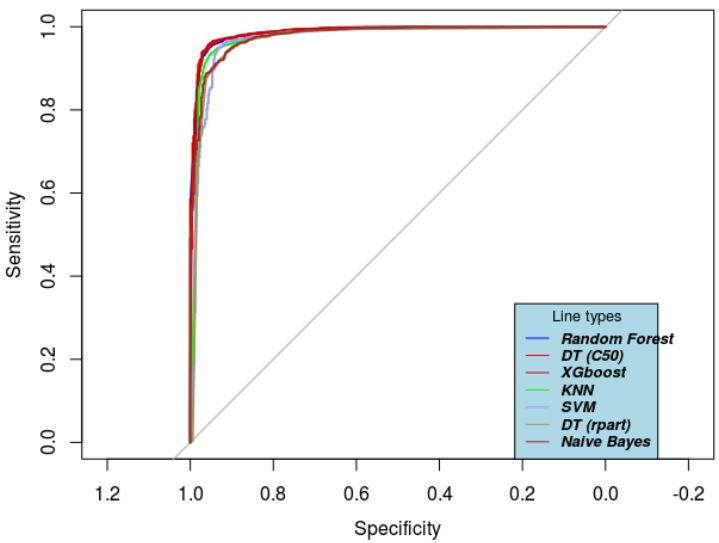
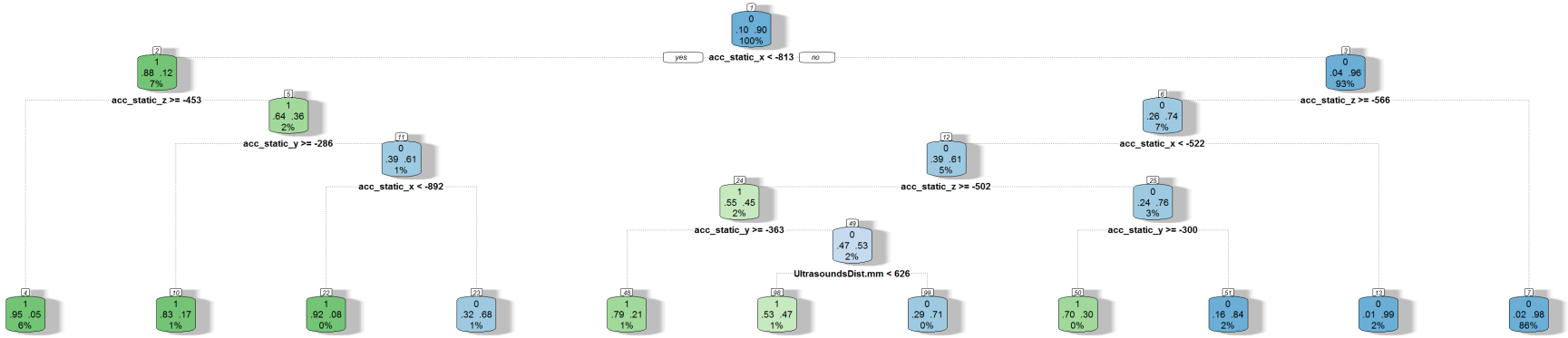
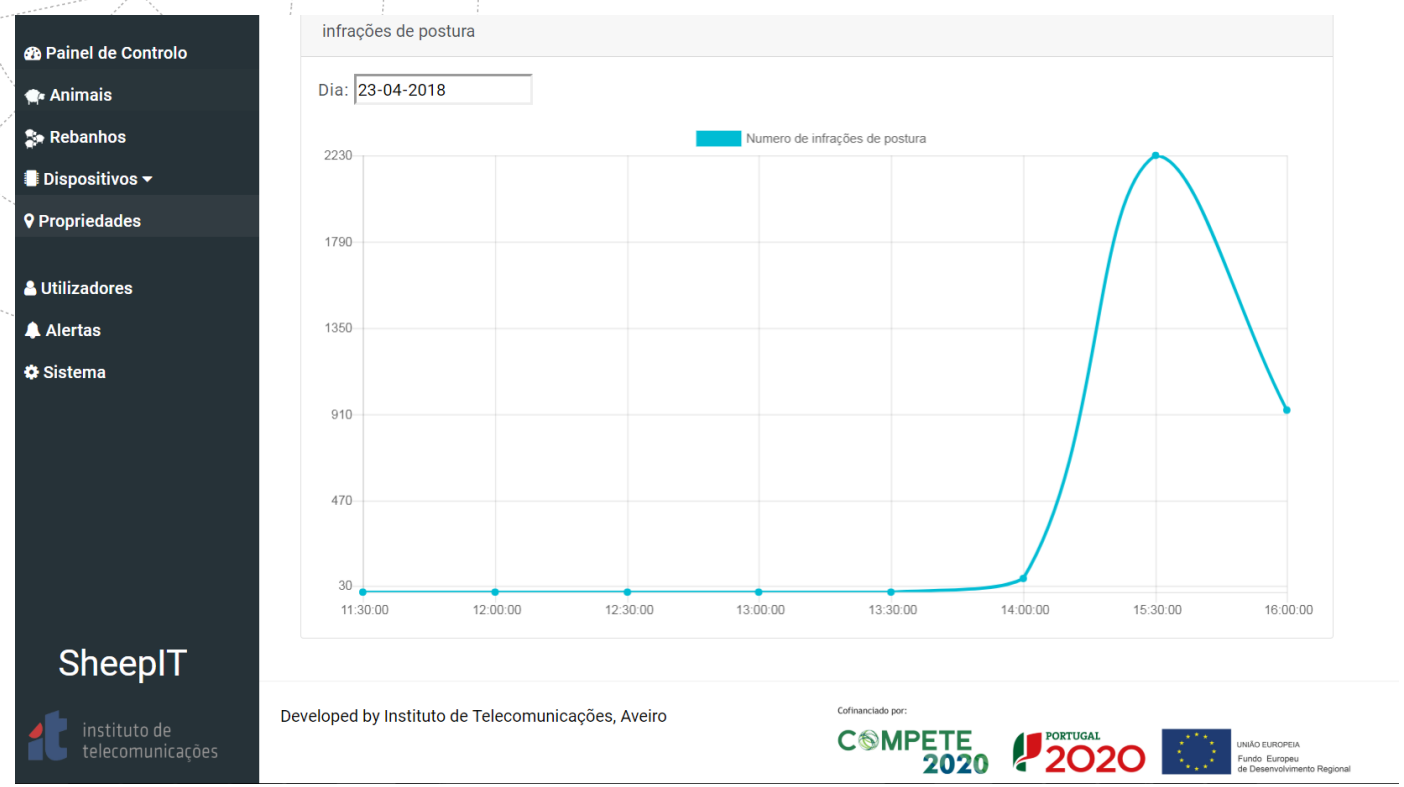


ML use case – detecting sheep's posture infractions



Rattle 2017-dez-05 11:40:09 Miguel Nóbrega

Webplatform



Webplatform

Ver Coleira no Mapa

admin

Mapa

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Webplatform

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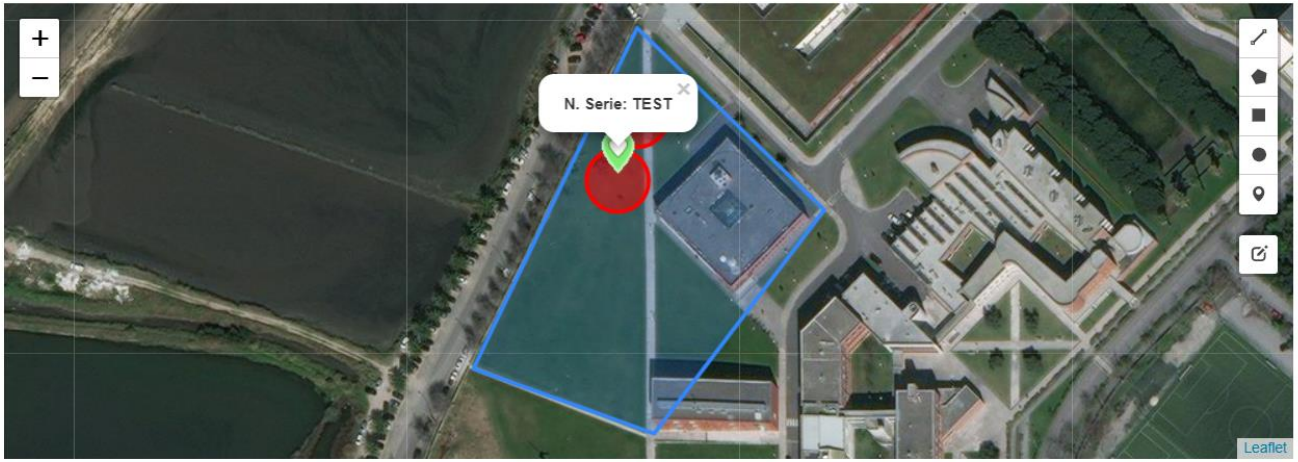
Mapa



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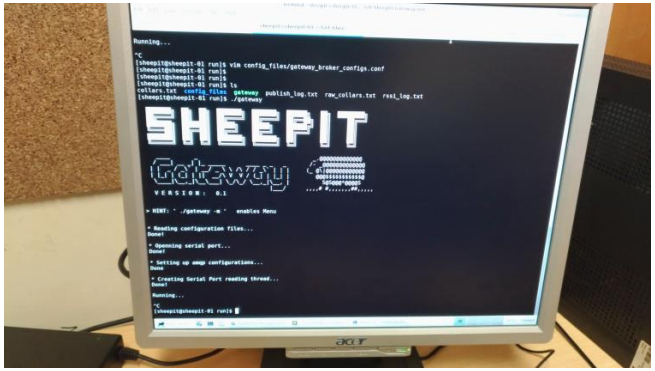
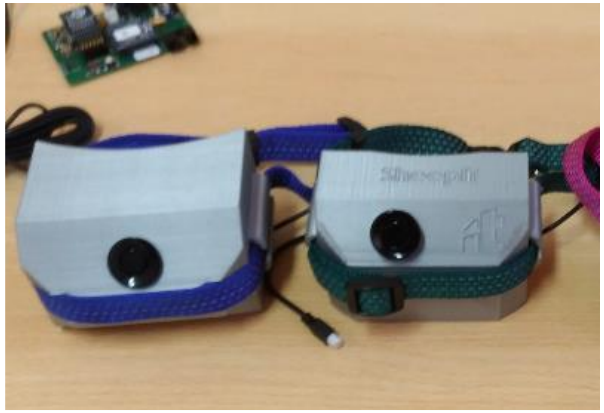
Conclusion

- Weed control entails on a significant economic and labor efforts from winemakers;
- Sheep may be an alternative if sheep's posture could be conditionate
- SheepIT project aims at solving that issue
- Offers an integrated platform, since the IoT local network until a could computational platform



Conclusion

- The overall architecture was implemented and a ML use case was tested
- Data was gathered using the implemented network and ML algorithms used to detect posture infractions
- DT were specially relevant to retrieve useful information to the algorithm development



Future work

- Extend the posture control algorithm for lands with big slope (as can be found in Douro's region)
- Evaluate the platform performance and scalability with larger amounts of devices
- Evaluate other ML use cases (e.g. detection of illness, panic attacks, patterns of movement, food preferences, etc).

Thank you for your attention!

Questions?

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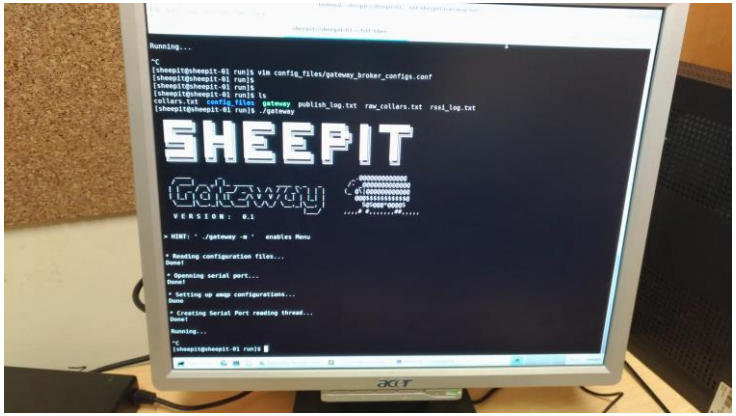
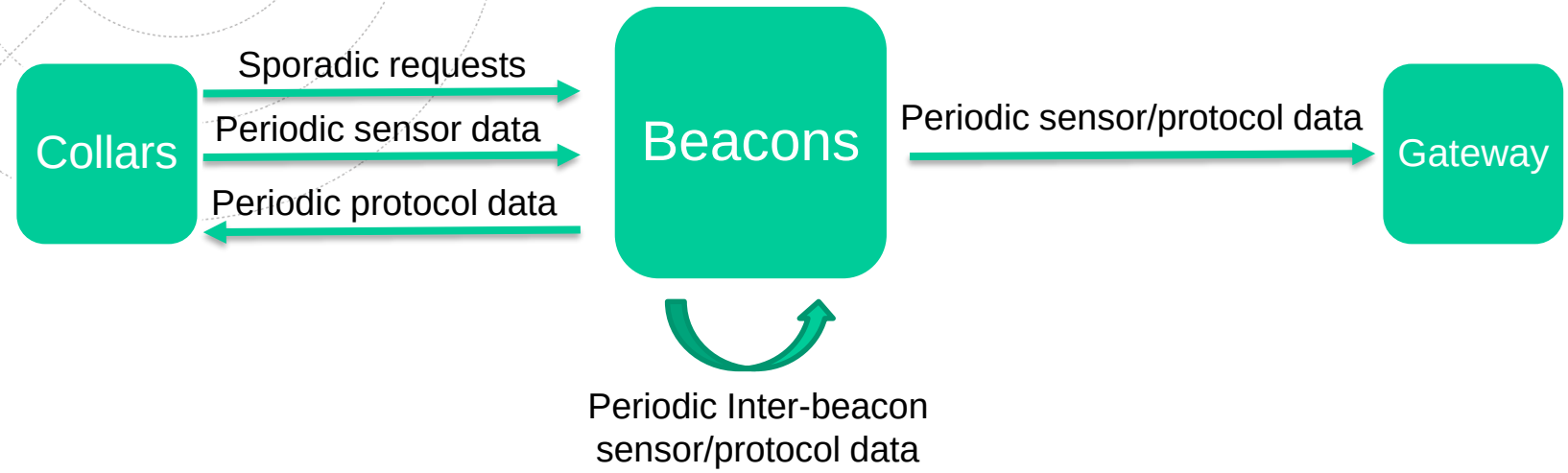
EXTRA SLIDES


Globaltronic


SHEEPIT
Gateway
VERSION: 0.1

SheepIT IoT Networking Architecture



SheepIT IoT Networking Architecture

- uC common structure
  - Beacon window, where beacons send short synchronization and protocol data;
  - Turn-around window for local processing
  - A window for transmitting specific data to each uC
    - Eg. In a uC type 2, the window is used for collar's data transmission