

# CAPDOM Project: Sensor Networks for Biodiversity Protection

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## Wireless Sensor Networks (WSN)

- Set of wireless sensor able to sense environment parameters
- First used for collecting data to a base station
- Researches lead to use WSN for in situ treatments

### Application fields

- places monitoring (building, public square)
- patient monitoring (in-hospital, in-situ, at home)
- military concerns (strategy)
- wildlife monitoring (species monitoring)

## IDC team : Engineering data and knowledge

- Distributed decision [2, 1, 3, 4, 5, 7, 6]
  - ▶ applied to patient monitoring
  - ▶ tested on real wireless sensors
- Social networks and behavior
- Species monitoring
- Tests and validation





# Outline

- 1 Introduction
- 2 Sensors and Behavior
  - Introduction
  - Why sensors ?
  - Contributions
  - Applications : Bird Communities
- 3 Study of an Endemic Species
- 4 Tests and Validation
- 5 Conclusion

# Sensors and Behavior

## Introduction

### Two categories of methods :

- Visual study
  - ▶ Not suitable for all kinds of environment
  - ▶ Time of observation limited
  - ▶ Source of errors
- Grafted solution (GPS, RFID, ...)
  - ▶ Needs open areas
  - ▶ Relatively expensive
  - ▶ Grafted on the animal

### Solution :

Moving towards fixed solution : SENSOR

# Sensors and Behavior

## Why sensors ?

### Sensors :

- Different kinds of environment
- Several individuals
- Easy to set up
- Does not affect the animal

# Sensors and Behavior

## Contributions

### **Contributions :**

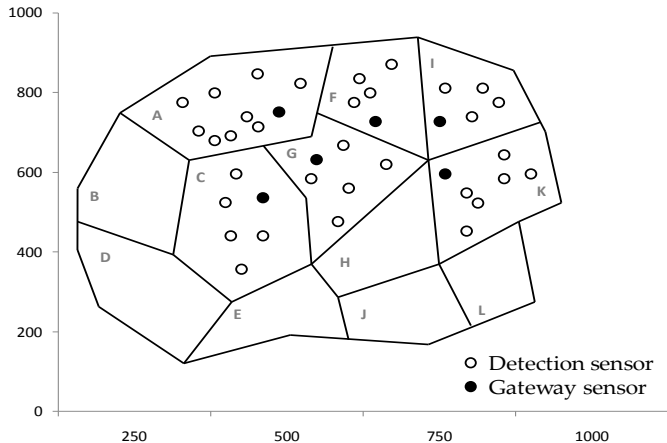
- Architecture for data collection [12]
- Counting individuals [9, 8]
- Tracking collective behavior patterns [13]
- Social communities extraction [14]



# Sensors and Behavior

Applications : Bird Communities

## Architecture :

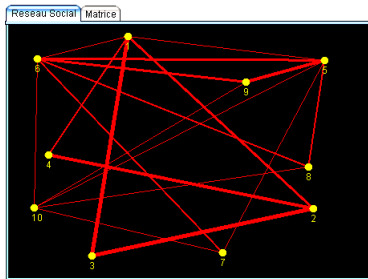


# Sensors and Behavior

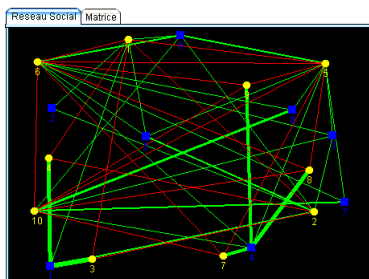
Applications : Bird Communities

## Social Data Collection :

- Two kinds of social link :
  - (a) Bird-to-Bird : (*2 birds are in the same region*)
  - (b) Bird-to-Region : (*1 bird in a region*)



(a)

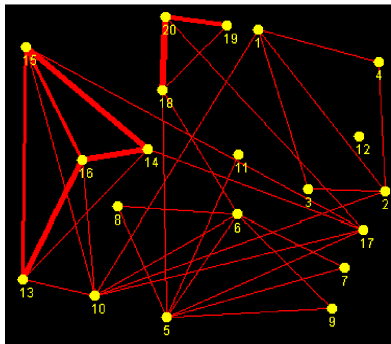


(b)

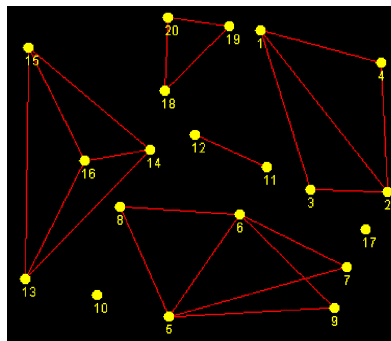
# Sensors and Behavior

Applications : Bird Communities

## Communities extraction :



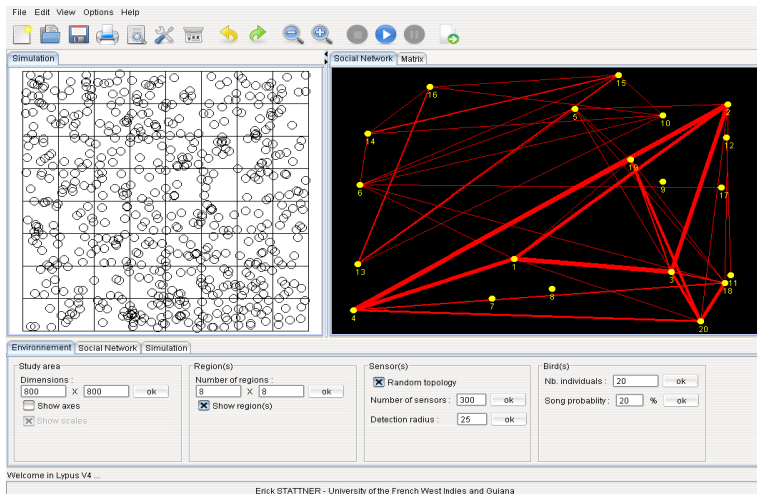
(c)



(d)

# Sensors and Behavior

Applications : Bird Communities



# Outline

- 1 Introduction
- 2 Sensors and Behavior
- 3 Study of an Endemic Species
  - Context
  - Works methodology
  - Works in progress
- 4 Tests and Validation
- 5 Conclusion

# Study of an endemic species

## Context

### **WSN for species monitoring**

- Monitor a wild area
- Regulate the spread of invasive species
- Help to protect endangered species.

### **Our aim**

- Study an endemic specie :
  - ▶ White-breasted Thrasher (*Ramphocinclus brachyurus*)
- Characterize its habitat :
  - ▶ White-breasted presence and abiotic factors

# Study of an endemic species

## Works methodology

- Song recorders and wireless sensors
- First step : know areas
  - ▶ record samples from the field
  - ▶ listen samples from the field
  - ▶ build recognizer for the detection
- Second step : uknow areas
  - ▶ record samples from the field
  - ▶ recognize the White-Breasted
  - ▶ build a cartography of the species habitat

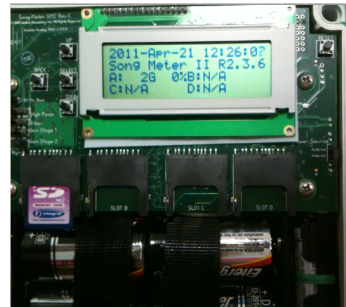


*A Song Meter and an eKo*

# Study of an endemic species

## Works methodology

- Five hours of recording per day
  - ▶ One month of compress recording
  - ▶ 5h30 (for 5h) and 18H (for 1h)



*The Song Meter*



# Study of an endemic species

## Works methodology

- Five hours of recording per day
  - ▶ One month of compress recording
  - ▶ 5h30 (for 5h) and 18H (for 1h)
- Four sensed abiotics factors
  - ▶ soil moisture
  - ▶ solar radiation
  - ▶ ambient temperature
  - ▶ ambient humidity



*The eKo sensor*

# Study of an endemic species

## Works methodology

- First recognizers
  - ▶ build on perfect samples
  - ▶ recognize some White-breasted
  - ▶ allow to identify new samples
- Principle
  - ▶ Characterize the White-breasted song
  - ▶ Try several parameters
  - ▶ identify the best recognizer



*Whithe-breasted*

# Study of an endemic species

## Works methodology

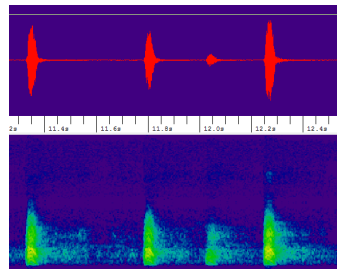
- Second recognizers : include our samples

| Date  | Time | State        |
|-------|------|--------------|
| 20/07 | 7h30 | Not usable   |
| 18/07 | 7h15 | Retained     |
| 19/07 | 7h29 | Retained     |
| 21/07 | 8h00 | Retained     |
| 27/07 | 9h04 | Retained     |
| 01/08 | 9h08 | Retained     |
| 04/08 | 9h54 | Not retained |

# Study of an endemic species

Works in progress

- Elaborate good recognizers
  - ▶ Based on two kind of samples
  - ▶ Enabling a right rate of recognition
  - ▶ Preventing from a high rate of false negative
- Extract moments of presence of the White-breasted
  - ▶ Retain moments of non-presence
  - ▶ Statistic and data mining analysis



*Whithe-breasted song wave*

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  - Context
  - Classification
  - Test Architecture
  - Contribution
- 5 Conclusion

# Context

## Research Context

- Classification of Usual Protocols over Wireless Sensor Networks
- Testing applications on Wireless Sensor Networks using formal methods.
  - ▶ Checking applications reactions over WSN to detect disfunctioning in order to classify faults.

# Classification

## Research Objectives

- Study and analyze the impact on performance system for various system parameters of sensors using ZigBee protocol.
- Test WSN with various routing protocol, and different parameters in MAC and PHYsical layer of 802.15.4 protocol.
- For routing protocols :
  - ▶ AODV, AOMDV, DSDV, DSR.
- For MAC and Physical layer :
  - ▶ Beacon-enabled mode, Non-Beacon mode, Transmission range.

To evaluate system performance we use the well-know NS-2 simulator for more realistic results.

# Test Architecture

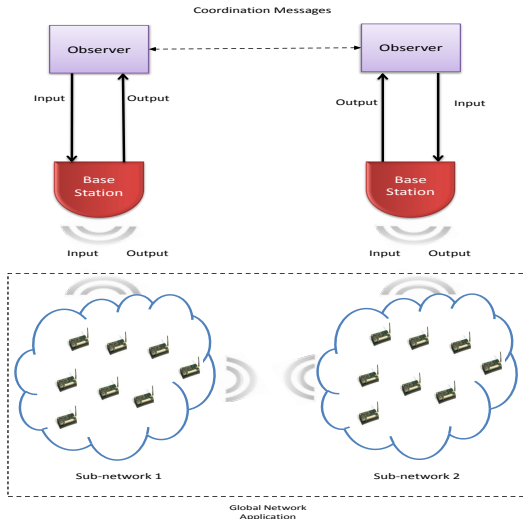
## Research Objectives

- An automatic scenarios generation (test sequences) from a formal specification of an application (UML or Automata specification).
- Experiment scenarios on a network to detect faults on applications or WSNs.
- Example of WSNs disfunctioning is :
  - ▶ Energy lake, Node congestion, Communication failure.
- We can classify faults in various categories :
  - ▶ Energy-consumption, Network congestion, Reliability about data dissemination, Security management.

In order to test our approach, we have used a real WSN, composed of five sensors, two base stations, and two computers.



# Test Architecture



# Contribution

## Contribution

- Classification of different system parameters for each layer involved in WSNs.[10]
- Check correctness of applications by monitoring scenarios on a network.[11]

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## Conclusion :

### Conclusion :

- Theoretical applications for wildlife monitoring
- Characterization of the white-breasted habitat
- Test and configuration :
  - ▶ Comparative study and guide users about how to choose the best system parameters
  - ▶ Model to check correctness of applications by monitoring scenarios on a network

### Perspectives :

- SenSoLin project :
  - ▶ Highlighted best parameters for wildlife monitoring
  - ▶ Large scale field deployment

## Conclusion :

Thanks for your attention



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