



**Le projet Prednet :**  
*de l'utilisation des réseaux de capteurs sans  
fil pour la surveillance d'animaux sauvages*

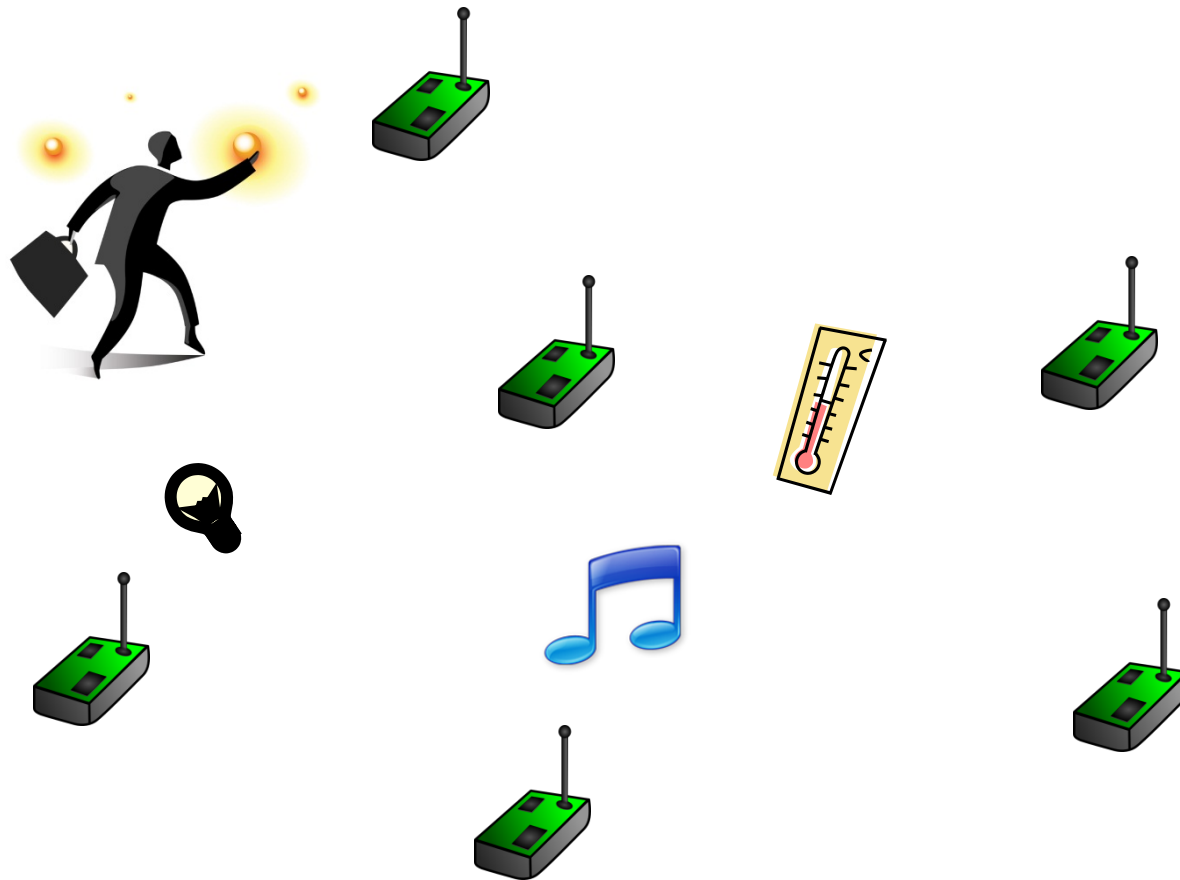
*Nathalie Mitton*

Journées Josy, 4 octobre 2016

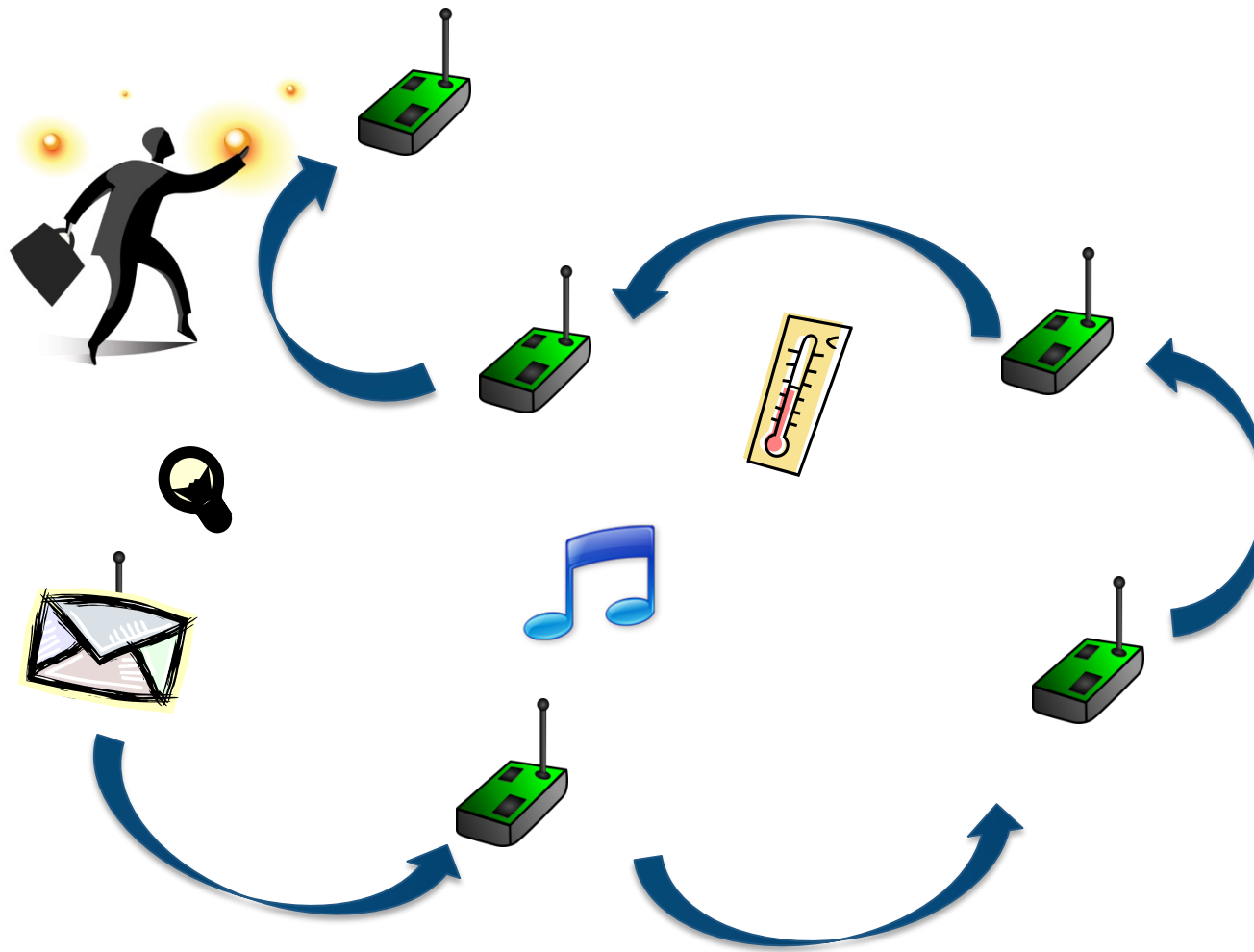
# What is a wireless sensor network ?



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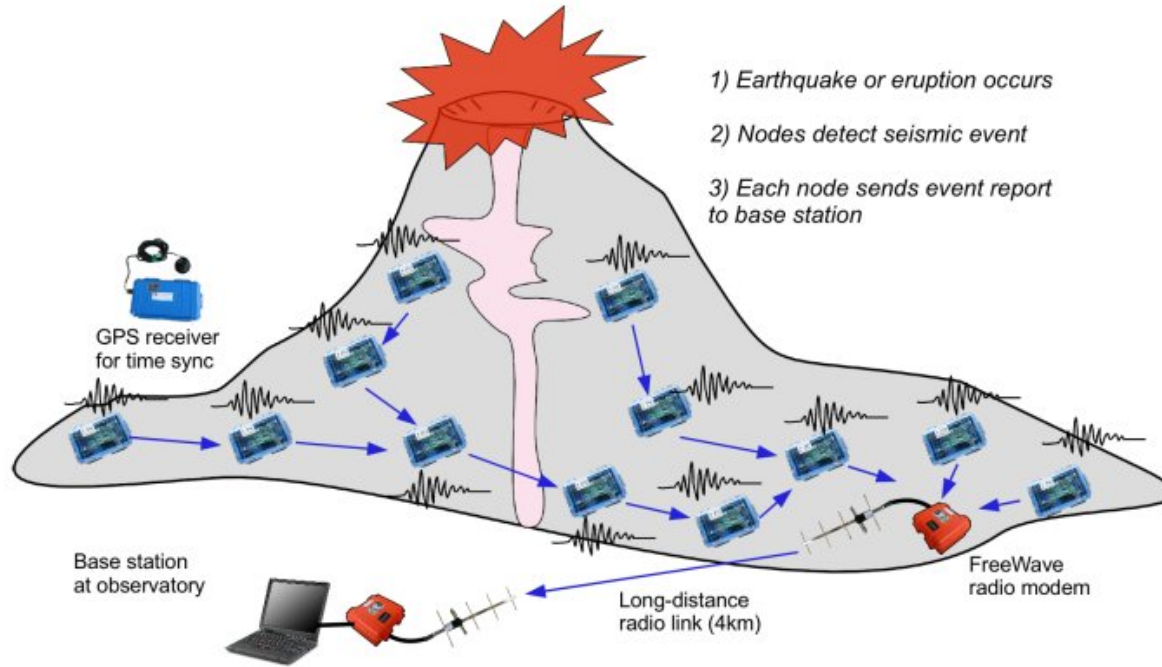


# What is a wireless sensor network ?





# Applications



# Research challenges



- Limited resources, wireless communications, dynamic topology
- Each sensor has a two-fold role :
  - Monitor an area and measure a physical value
  - Relay node in the network
- Design algorithms for:
  - Neighbor discovery,
  - Data collection, aggregation, routing
  - Activity scheduling



# Le projet PredNet

# Monitoring and protection of wildlife

Understand the behavior of wild animals

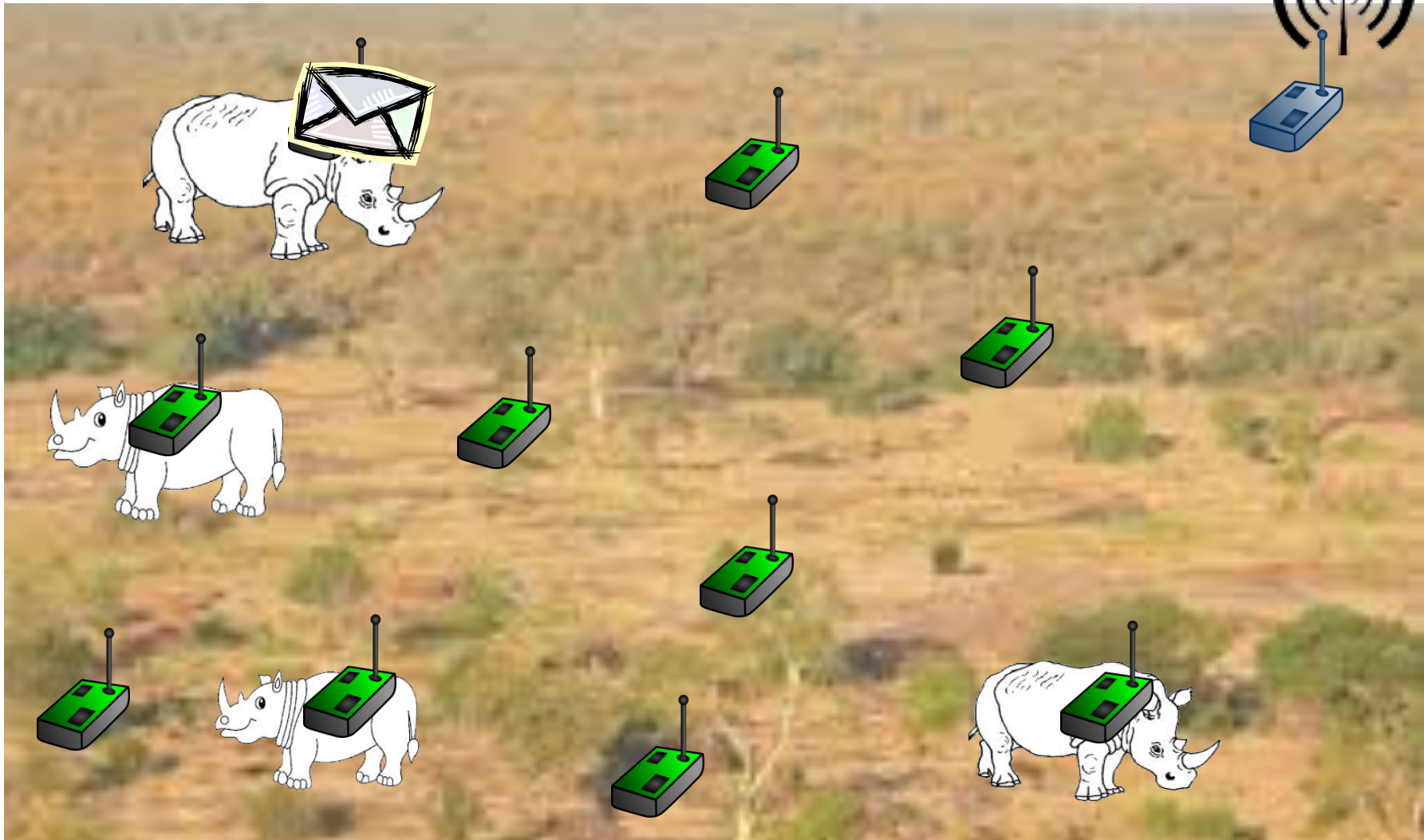
Fight against rhino poaching



Collaboration with Stellenbosch university, South Africa



# PREDNET Project



# Functional requirements

- The measured data must be sent every 15 minutes
- The WSN must be operational in the entire southern part of the Kruger Park
- Battery life must last at least few years
- The robustness of communications must be guaranteed (especially for the alarm mode)
- Delivery time for an urgent alarm message must not exceed 1 minute
- Node mobility must be taken into account

# Communication technology choice

Cellular?

Cons: energy consumption; coverage holes

IEEE 802.15.4, 802.11?

Cons: require large number of hops to cover the area;

Satellite solutions ? (Argos, Iridium, Globalstar)

Cons: expensive; energy consumption; limitations on data transmission

LPWAN ✓

# LPWANs

## Pros:

- Low power
- Long range
- Wide coverage
- Low device cost

## Cons:

- Mobility
- Low data rate
- Small message size

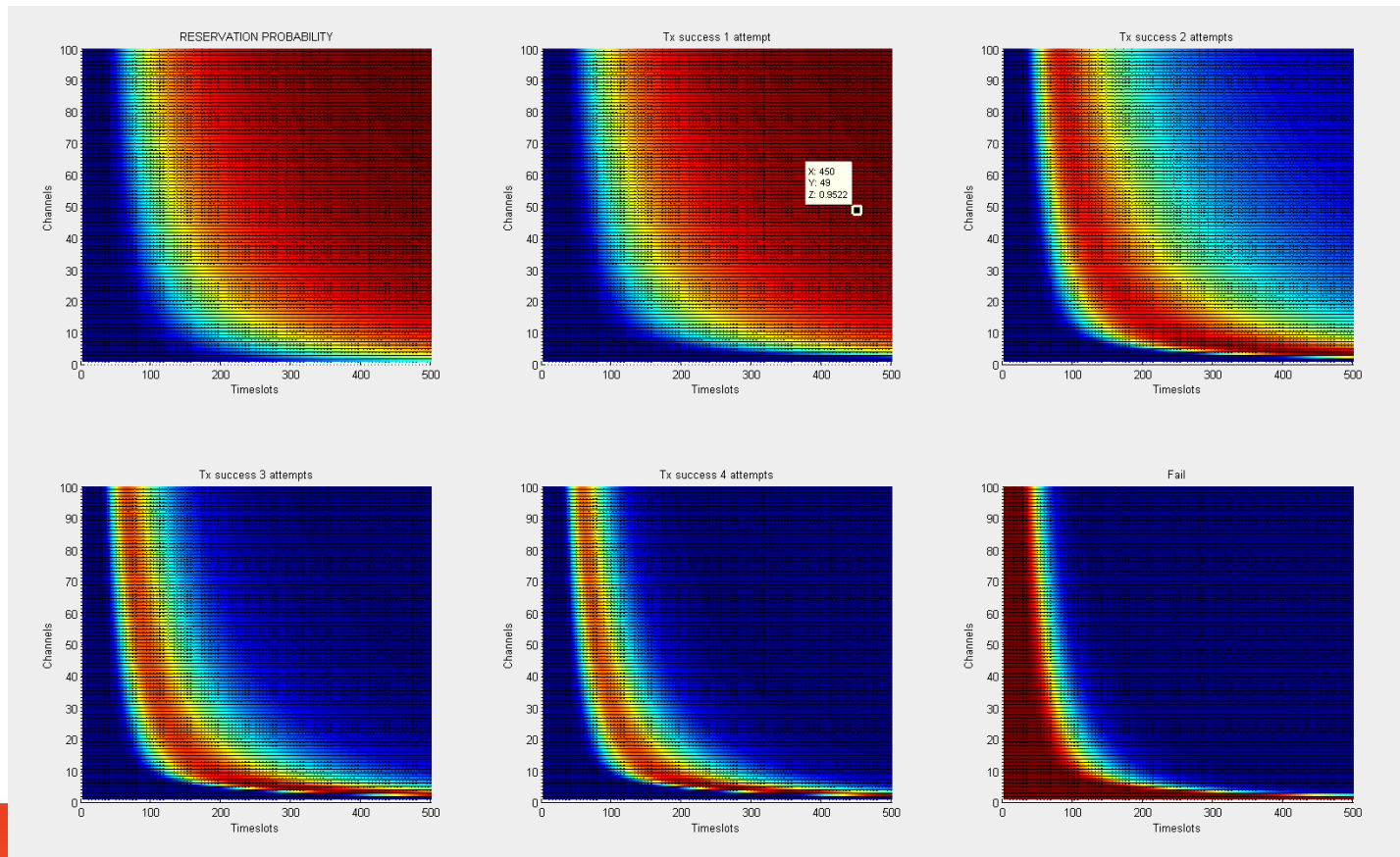


# Which LPWAN to choose?

Need long range

Use of stochastic geometry to estimate the probability

collision.



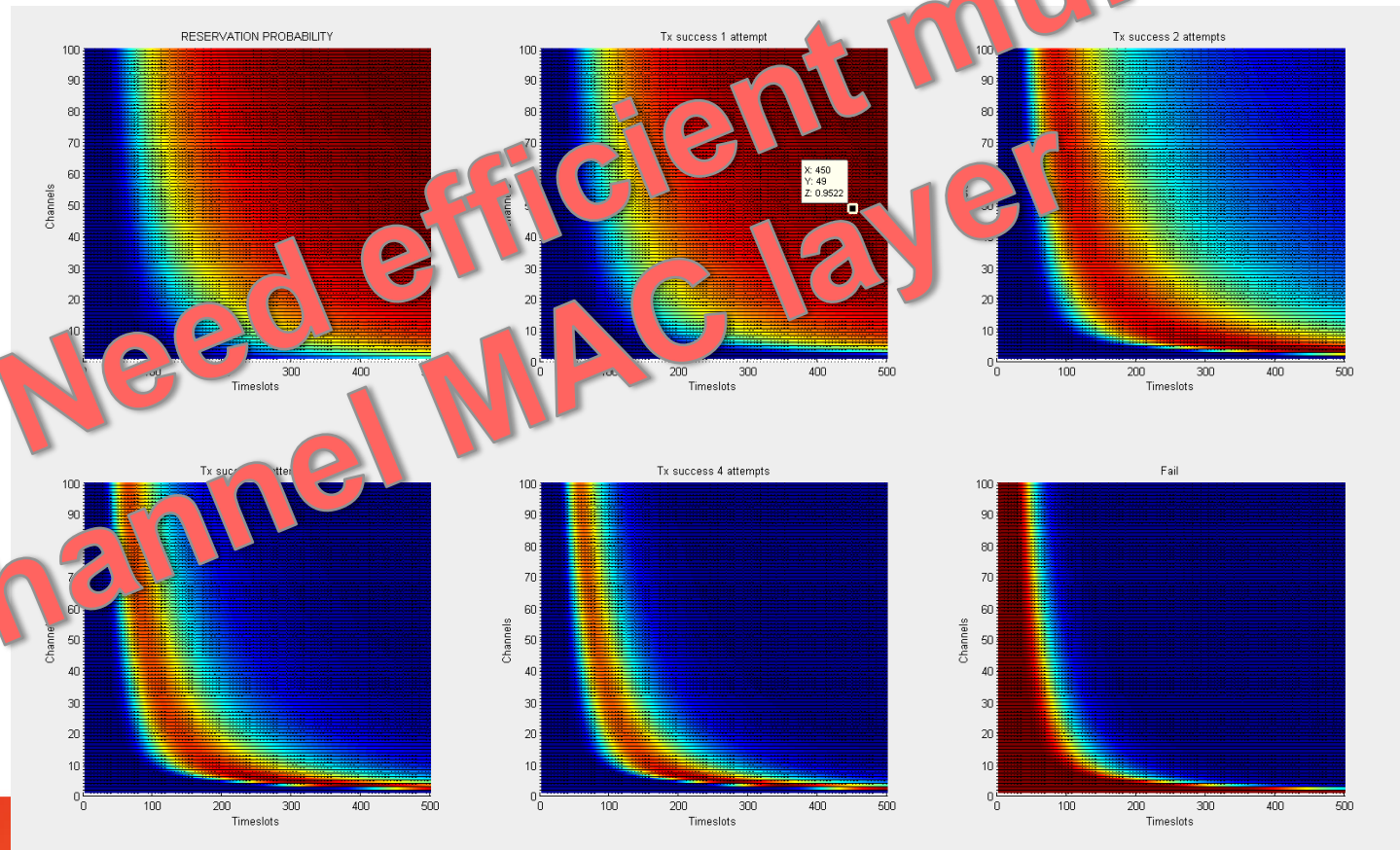
Theoretical analysis of problem

# Which LPWAN to choose?

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Use of stochastic geometry to estimate the probability

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Theoretical analysis of problem

# Which LPWAN to choose?

Sigfox?

- Cons: operator based; no coverage in South Africa

Weightless?

- Cons: not enough information; no drivers available

RPMA ?

- Cons: 2.4 GHz band; propagation issues in wilderness areas

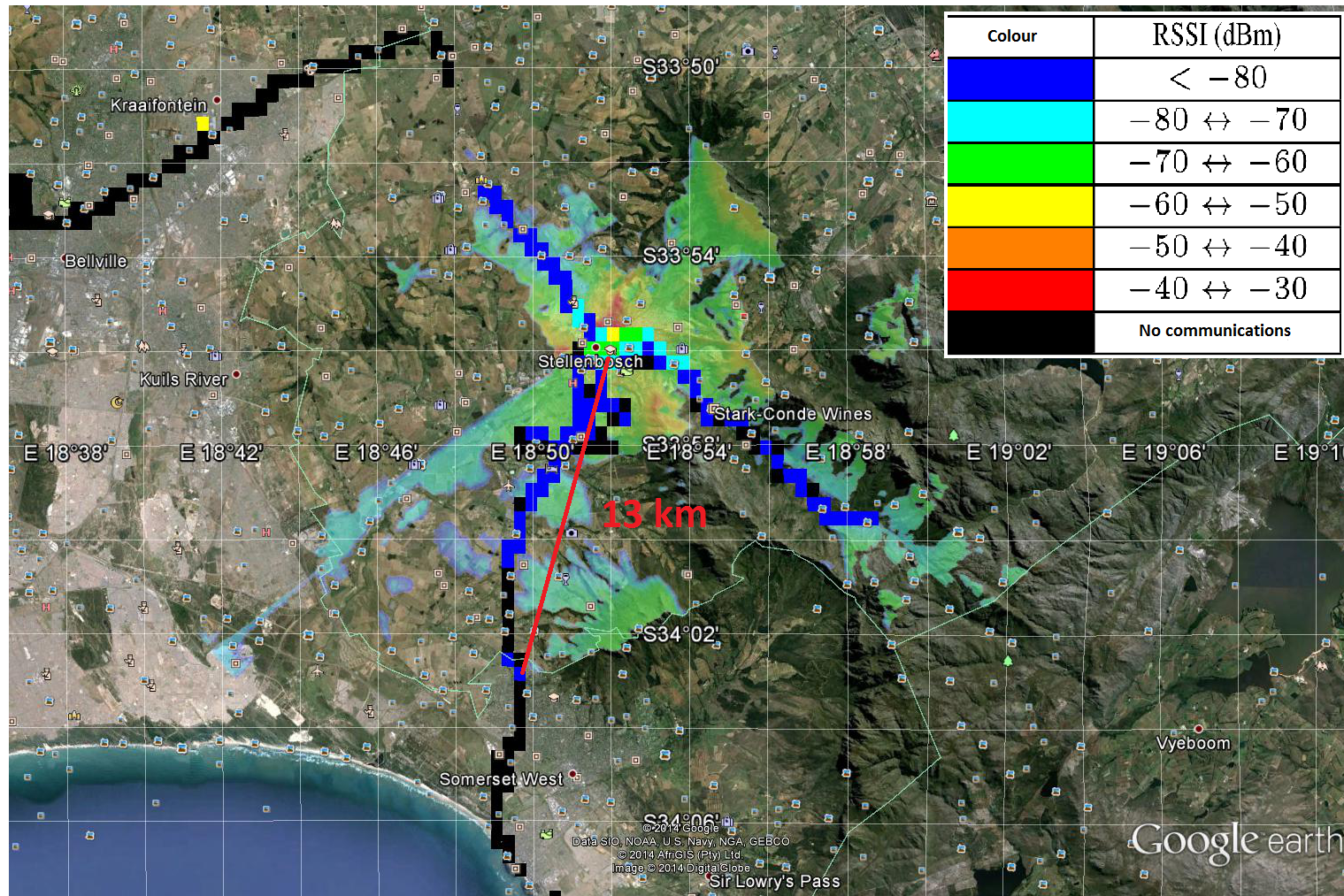
LoRa ✓

# Range test: urban scenario





# Range test + simulation: urban scenario



PER=11%

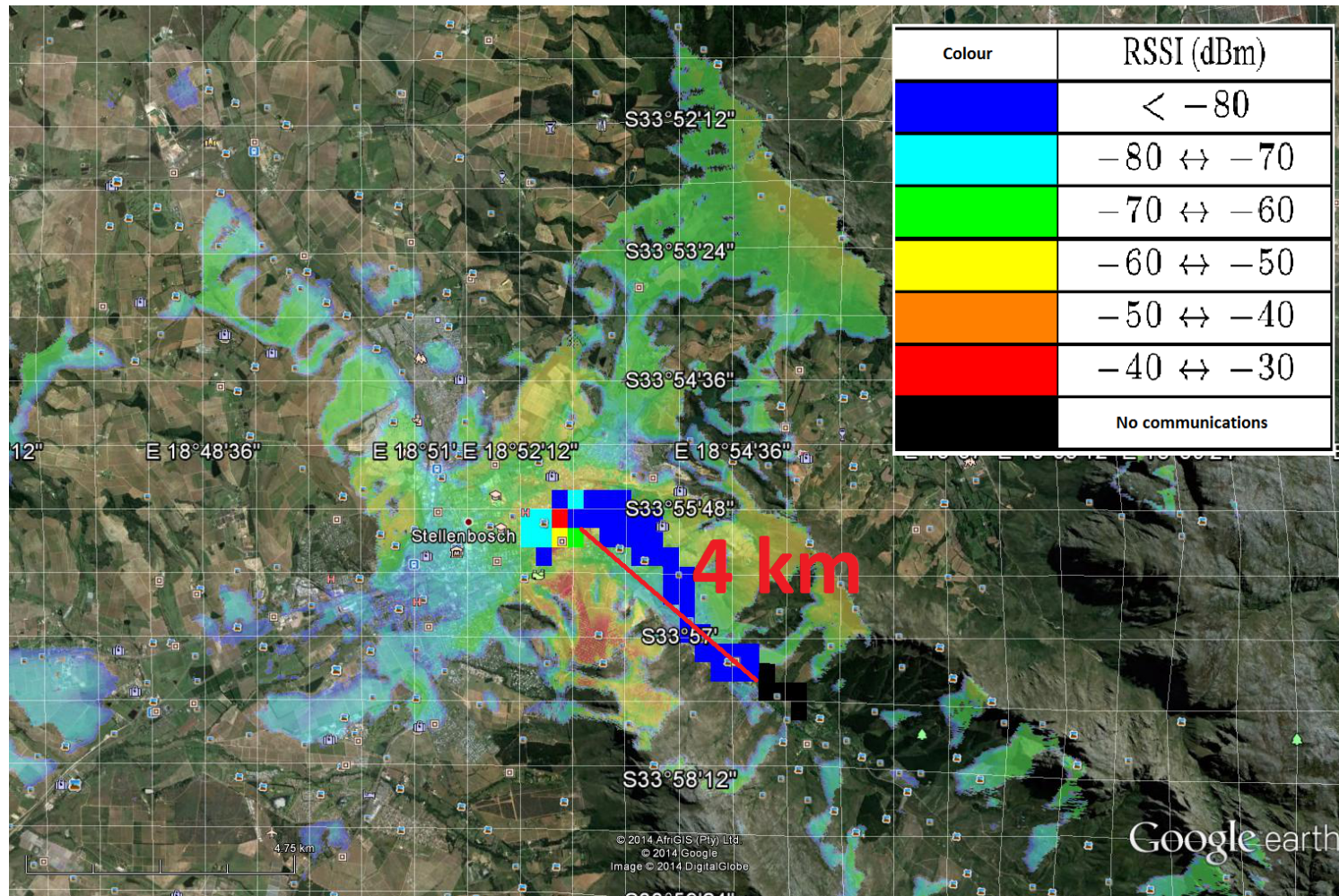


# Range test: rural scenario





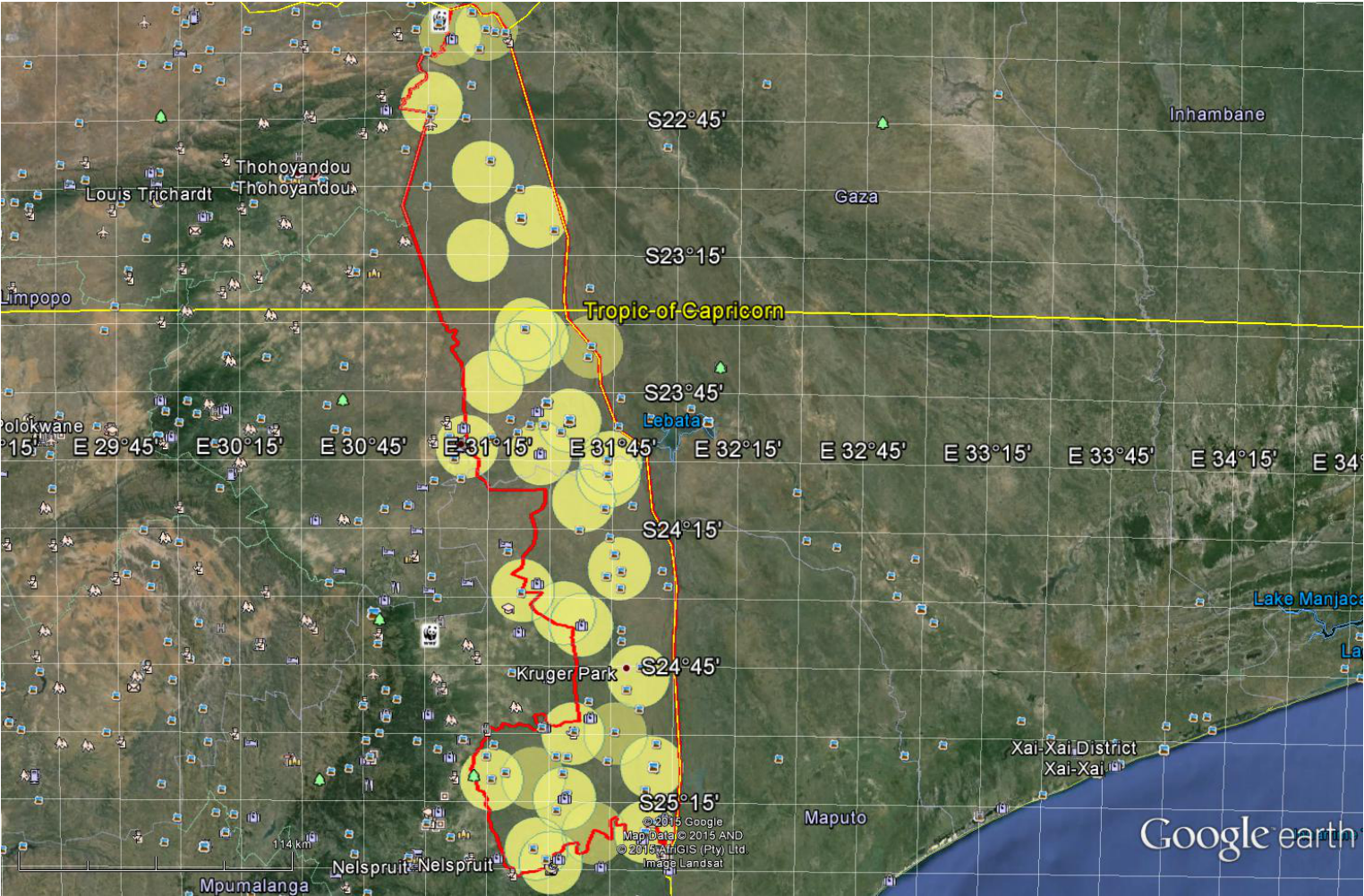
# Range test + simulation: rural scenario



PER=3.9%



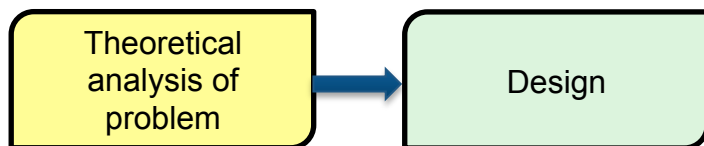
# Theoretical estimation: network coverage





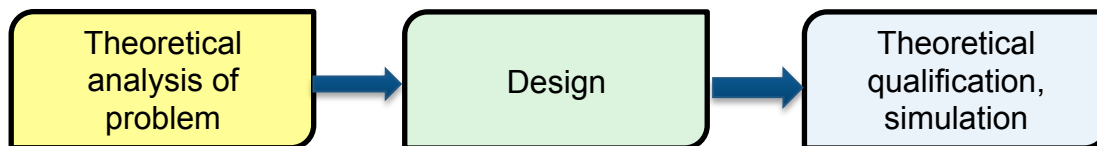
# Our approach - Design

- Dynamic Thomson-based channel selection
  - Learn from previous attempts
- Extend to multi-hop
  - Sender selects N channels with this technique
  - Receiver selects one listening channel

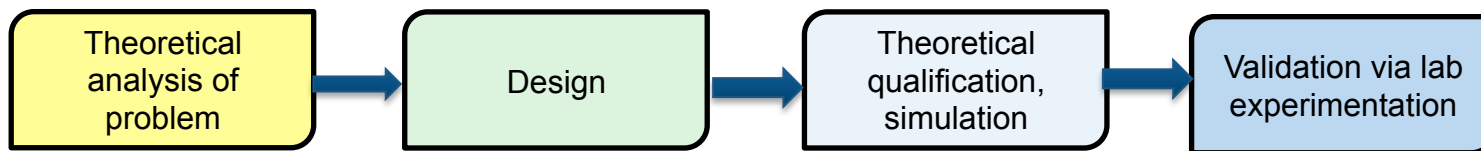
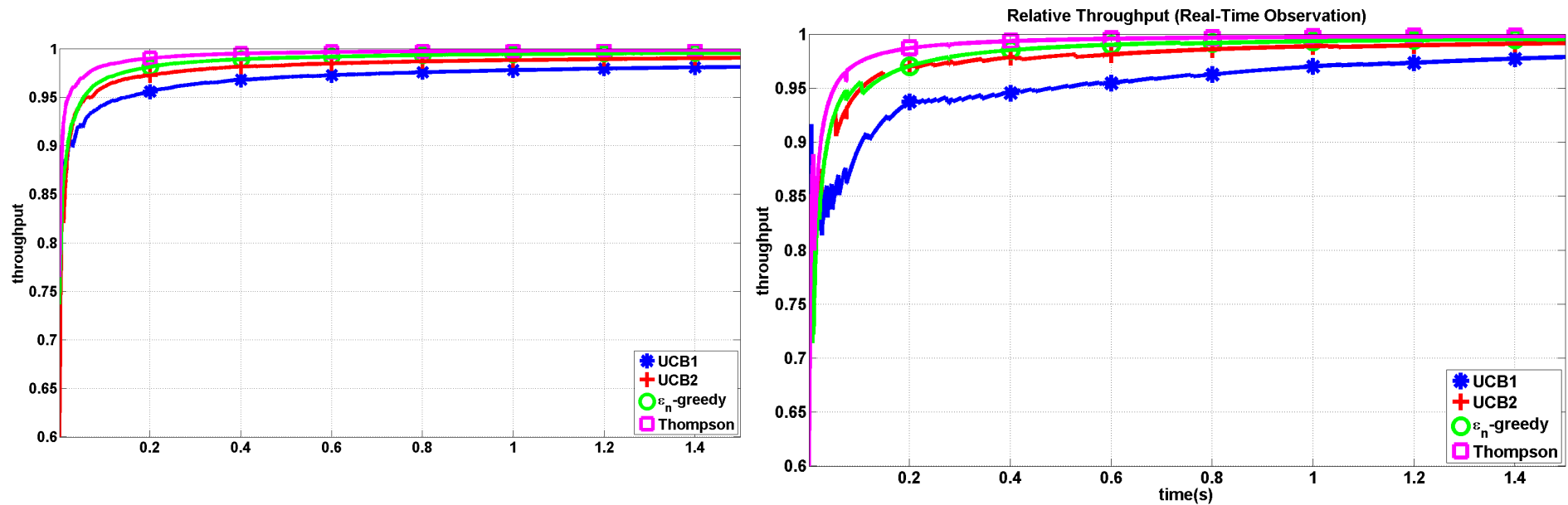


# Our approach – Evaluation

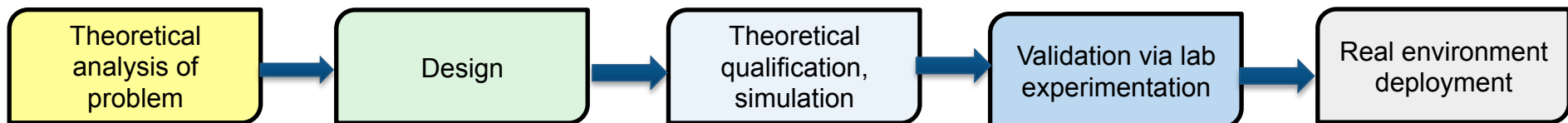
- Performance evaluation
  - Through simulations
  - Through theoretical analysis to bound the delay
    - Markov chain modeling



# Our approach – Testbed Evaluation

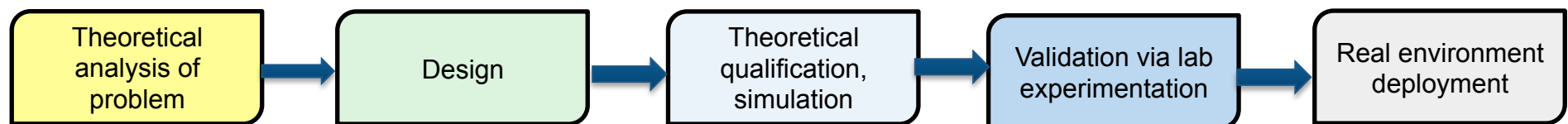


# Our approach – Device Validation



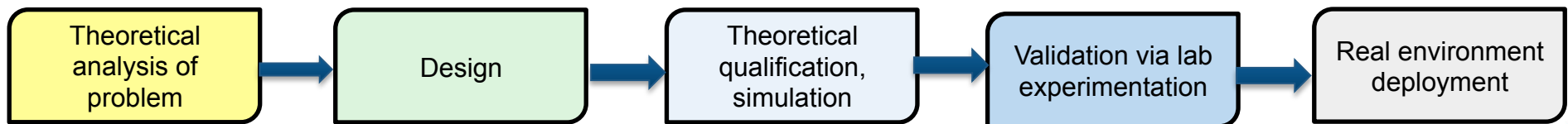
# Our approach – In site communication validation

- Deployment in Mozambique, close to the border with the Kruger Park
- Same vegetation/flora and ground environment
- But it turns the signal is greatly absorbed ☹
  - 100m range is apposed at the foot (300m if decrease of modulation speed)
  - 1 km if in the horn



# What was intended to be done

- Still remains the integration
  - The complete live deployments (not a piece of cake)
  
  - But re-scheduling
  - Find alternative communication technology (satellite)
- Or
- Find another way to use LPWAN





# Conclusions

# No universal solution

Each technology can suit for a given application.

Trade-off is the rule.



THANK YOU

*Inria*

INVENTEURS DU MONDE NUMÉRIQUE