The Internet of Things

These technologies which enable objects to connect and communicate

September 23th 2016

The Internet of things

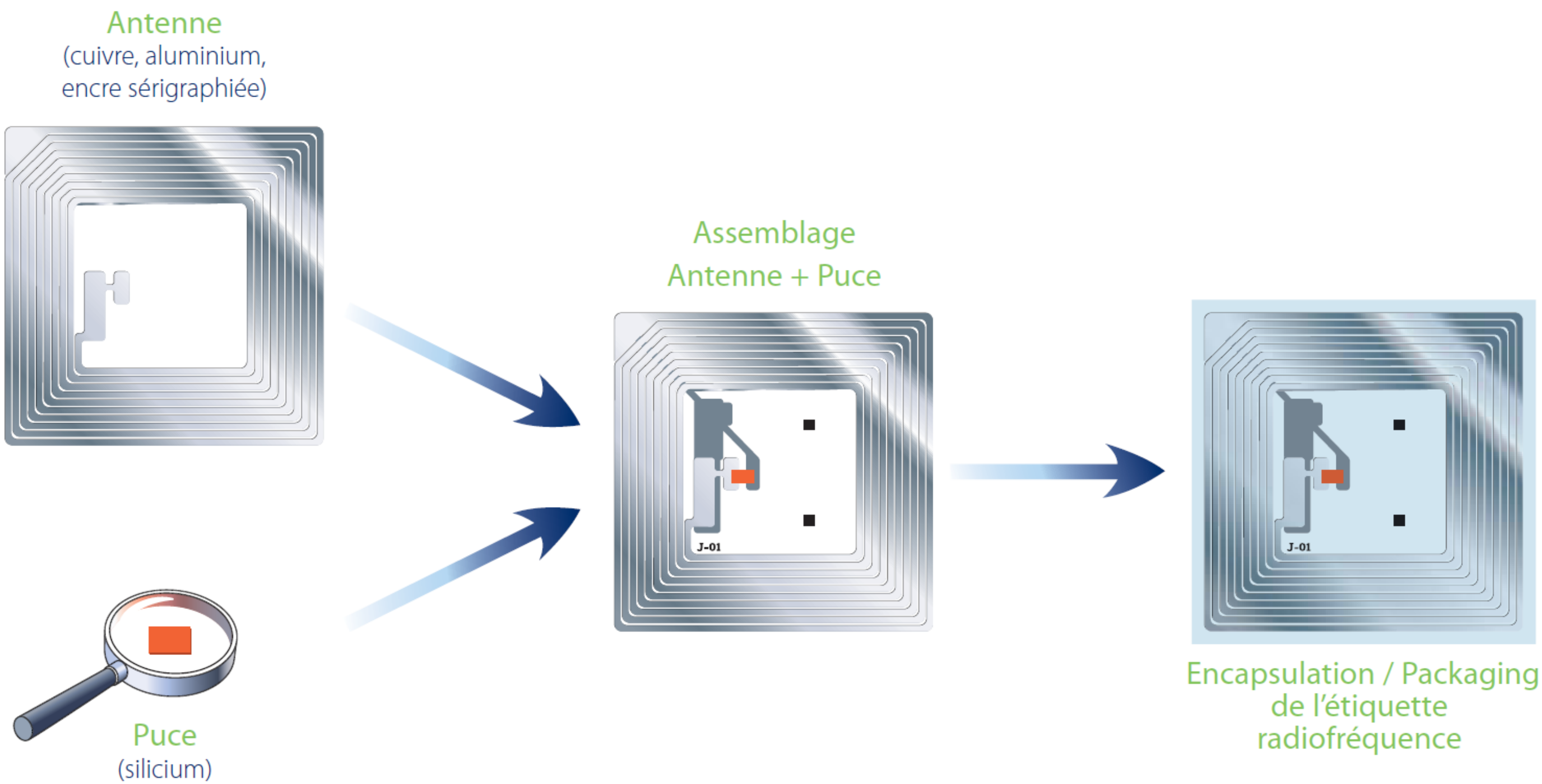
Give our objects / things

an id and means to communicate

RFID

Applications

RFID


Antenne
(cuivre, aluminium,
encre sérigraphiée)
Puce
(silicium)
Assemblage
Antenne + Puce
J-01
Encapsulation / Packaging
de l'étiquette
radiofréquence

RFID – Research challenges

From a hardware point of view

- Reduce antenna size and bulk
- Allow better readings in harsher and harsher environnment

From a software point of view

- Reduce collision
- Improve security
- Manage larger and larger datasets

The Internet of things and of the physical world

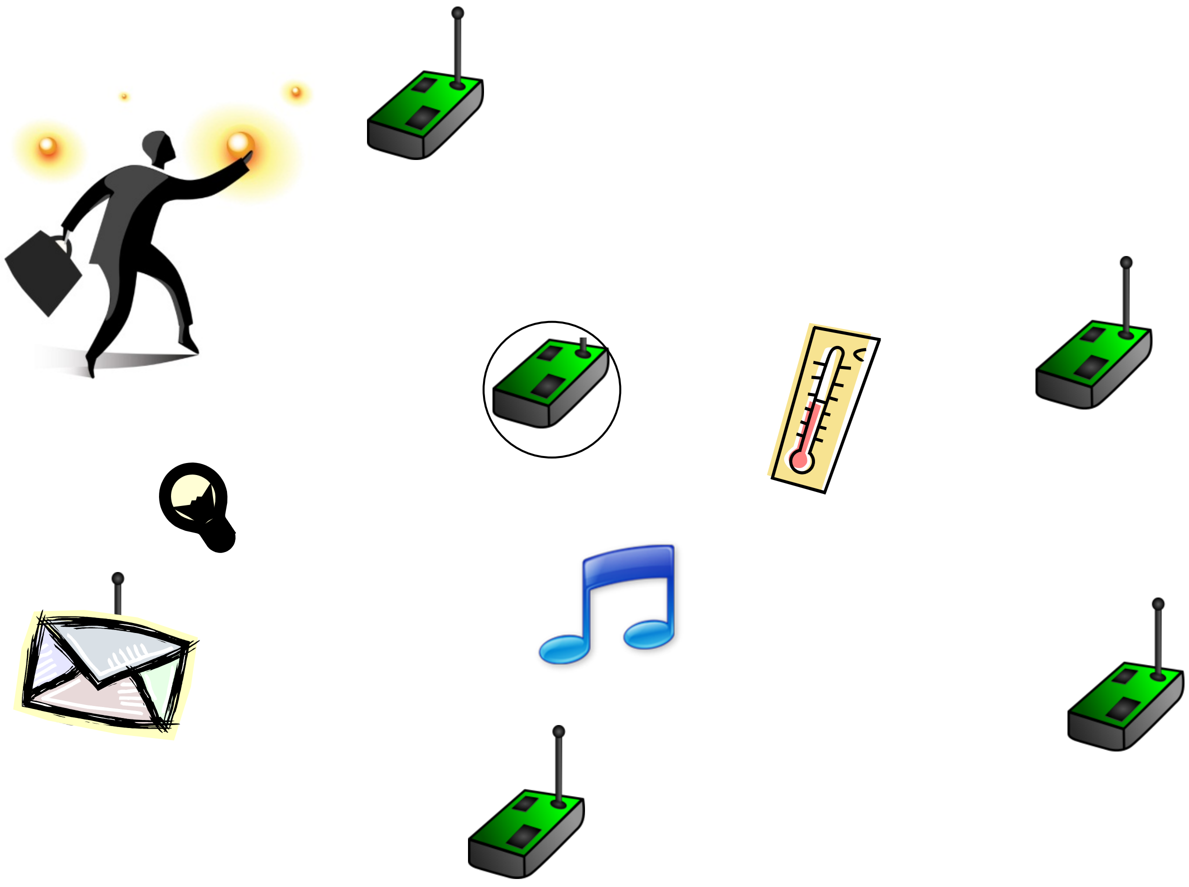
Give our objects / things and our environnement

an id and means to communicate

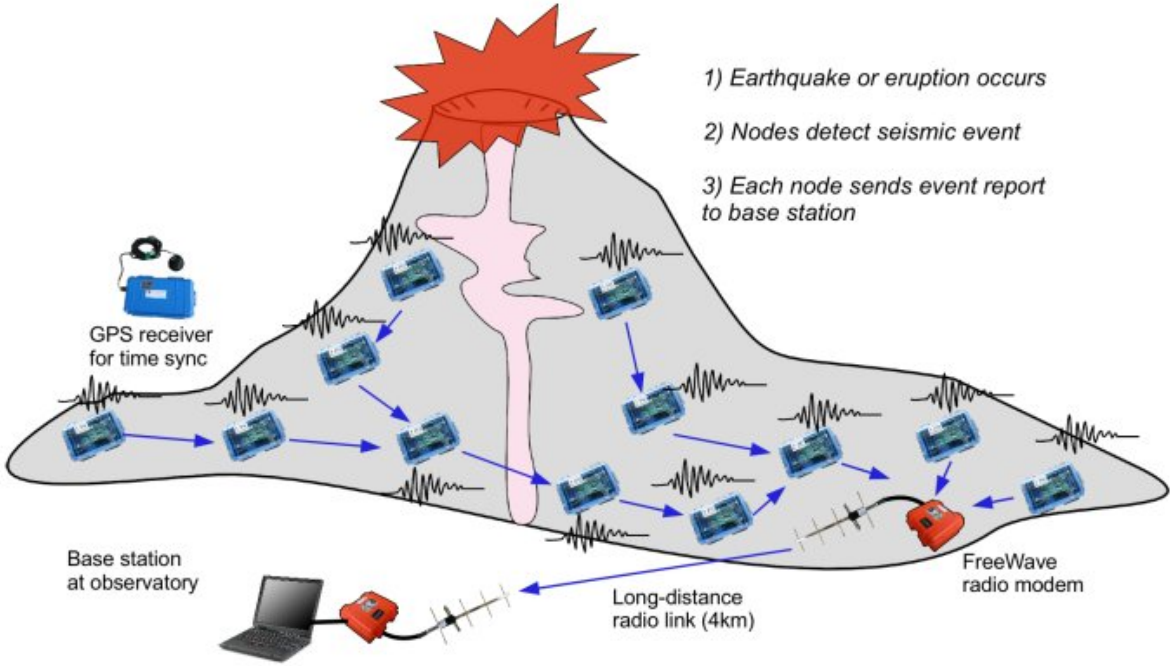
and know their status

RFID + wireless sensors

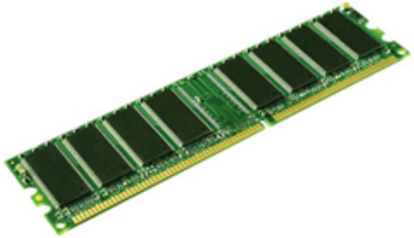
What is a wireless sensor network ?



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

The Internet of things and of the physical world

Give our objects / things and our environnement

an id and means to communicate

means to know their status

means to act and move on their environment

RFID + wireless sensors + wireless robots

Applications

Research challenges

- Same as for wireless networks with exploitation of mobility

Design algorithms to :

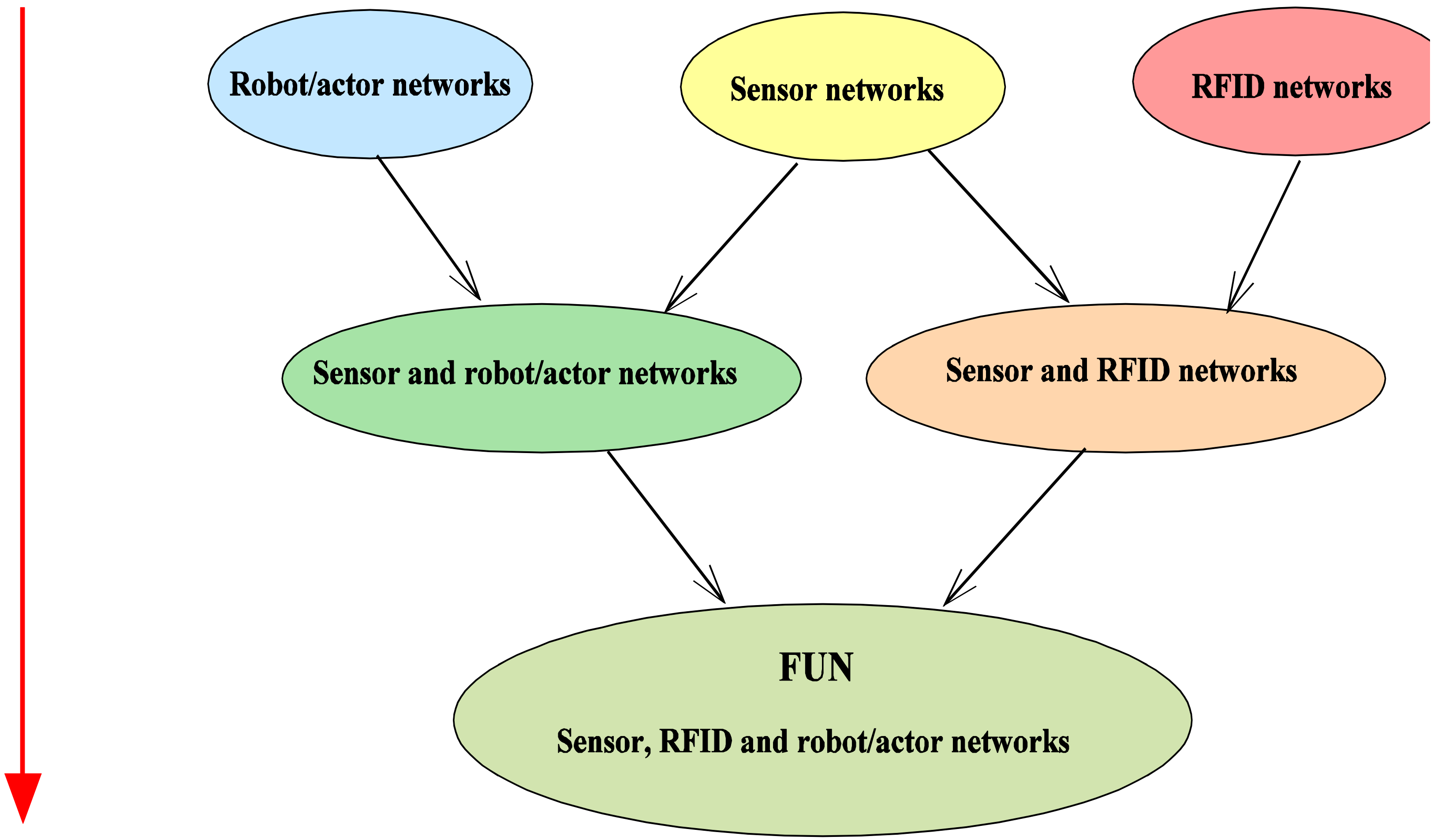
Self-deploy

Deploy other resources

Cooperate to reach a specific task

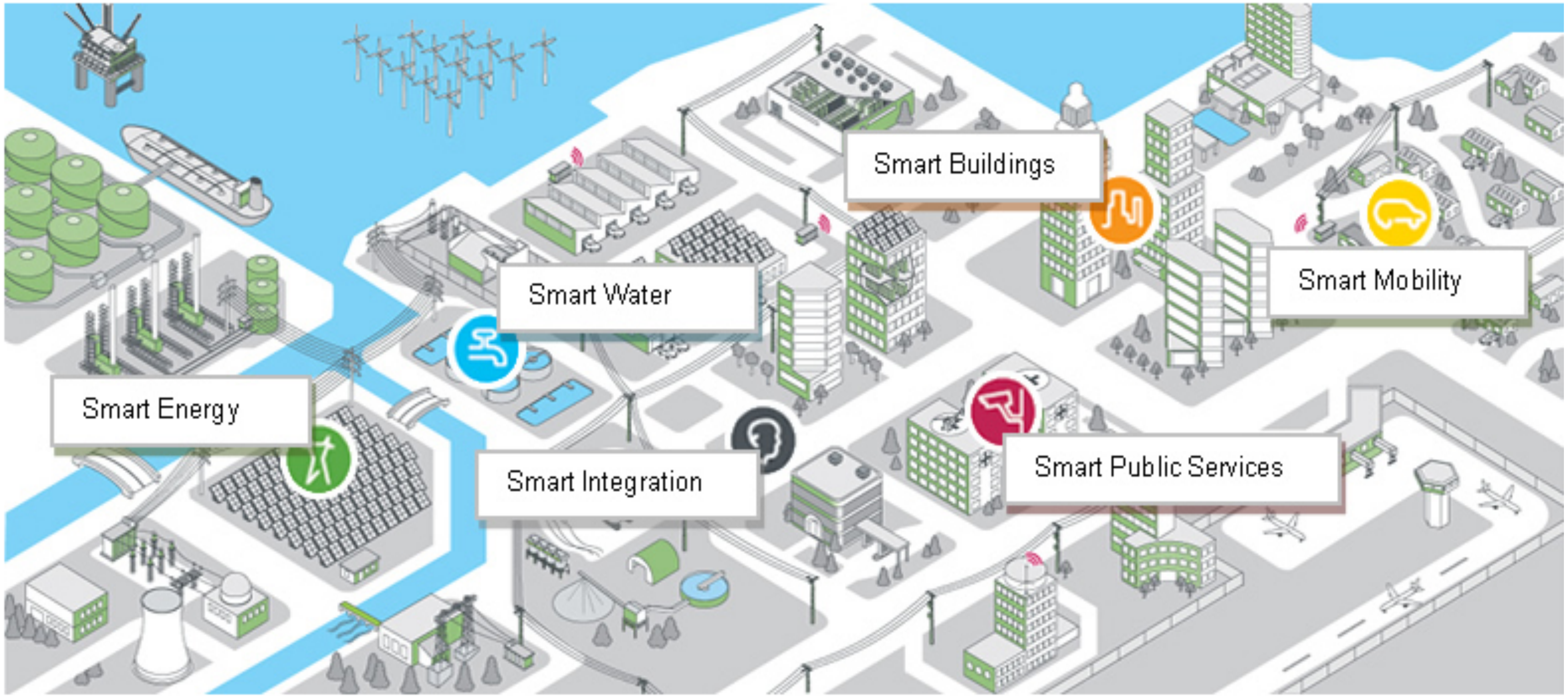
And when everything becomes a whole

Synergy



Robot/actor networks
Sensor networks
RFID networks
Sensor and robot/actor networks
Sensor and RFID networks
FUN
Sensor, RFID and robot/actor networks

Smart Cities



http://www.schneider-electric.com/sites/corporate/en/solutions/sustainable_solutions/smart-cities.page

Applications

- Exploration and continuous monitoring of hostile areas
- Augmented health care
- Dependable people assistance
- Smart cities
- VANETs
- …

A concrete example

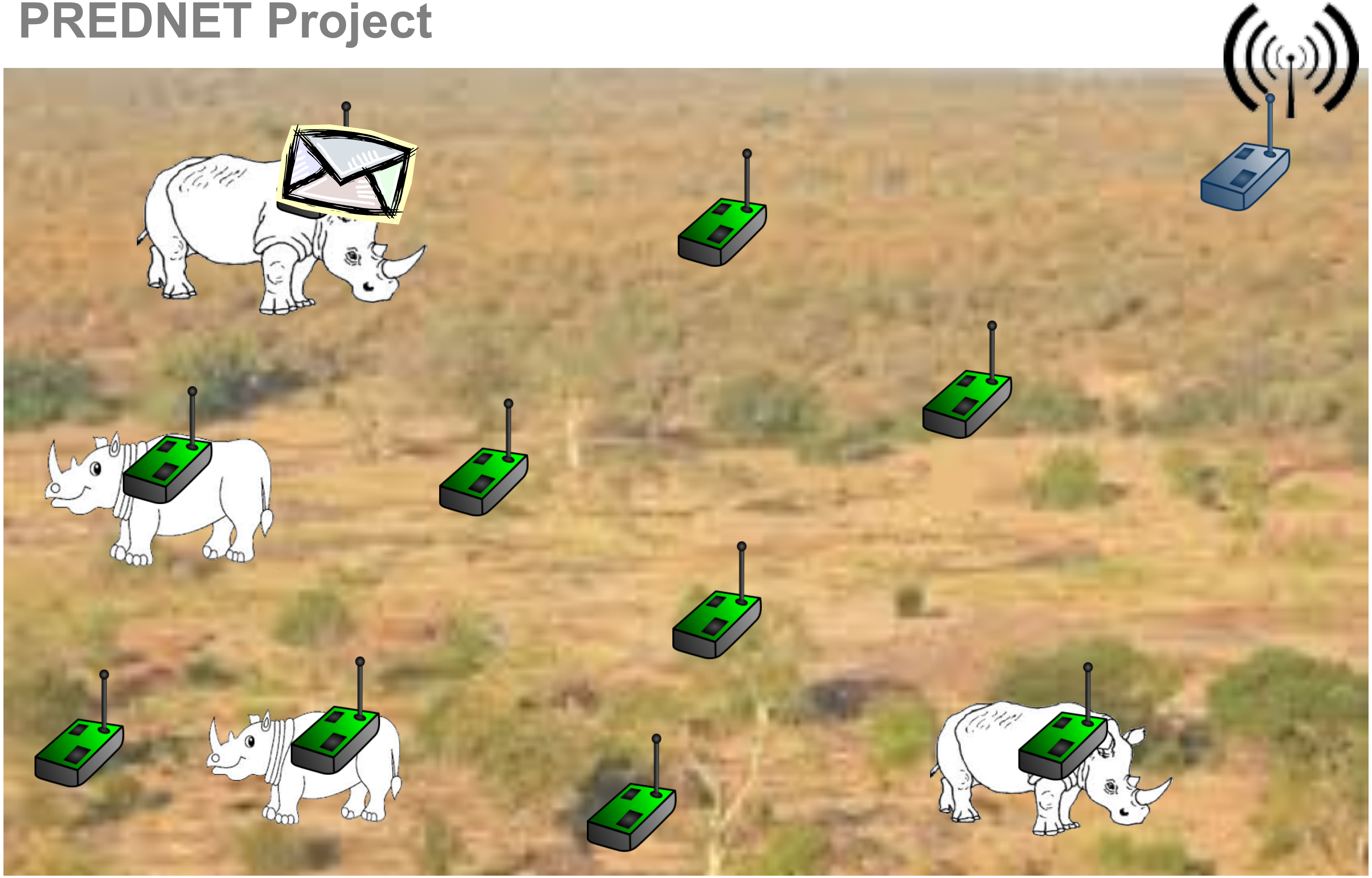
Monitoring and protection of wildlife

Understand the behavior of wild animals

Fight against rhino poaching

Collaboration with Stellenbosch university, South Africa

PREDNET Project



Our approach – analysis

Need long range

Use of stochastic geometry to estimate the probabilty

collision.

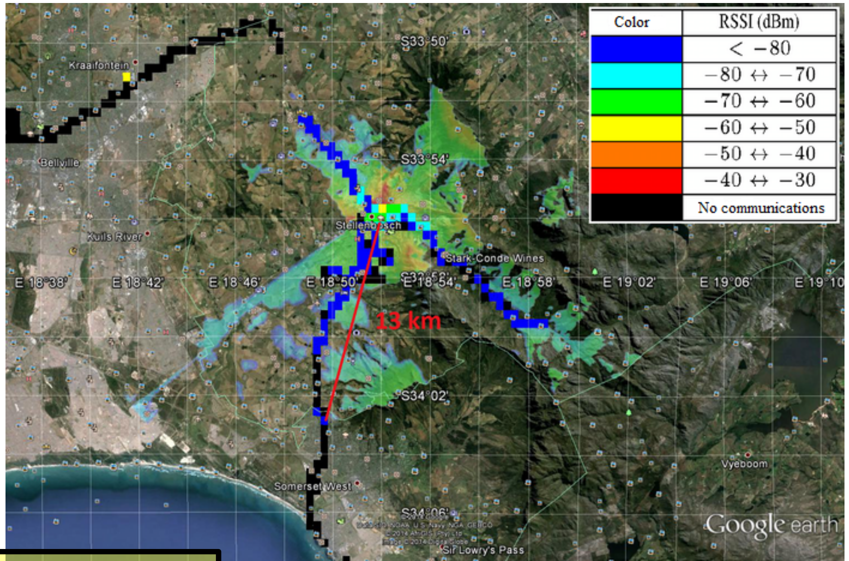
→ Need efficient multi-channel MAC layer

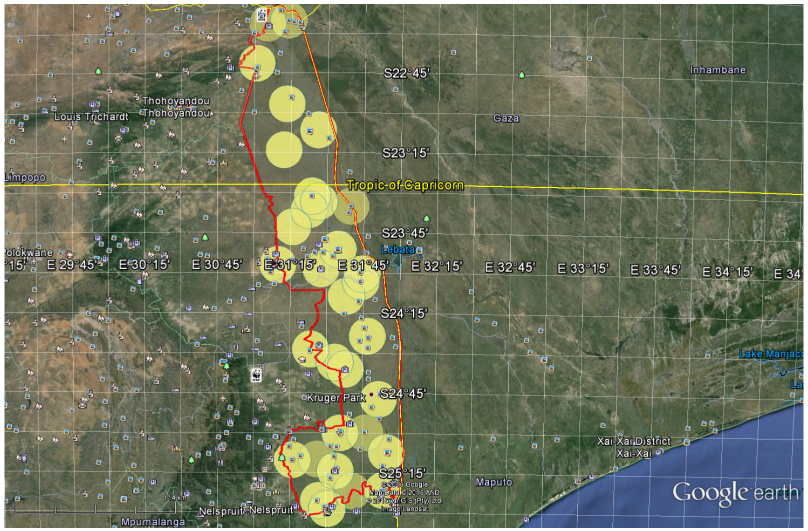
Theoretical analysis of problem

Our approach – analysis (2)

Need long range

Need efficient multi-channel MAC layer



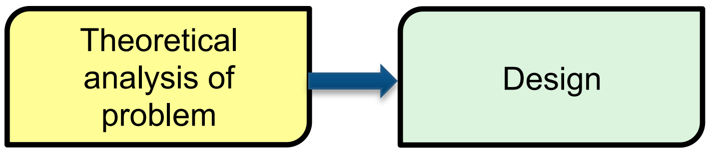


Theoretical analysis of problem

Our approach - Design

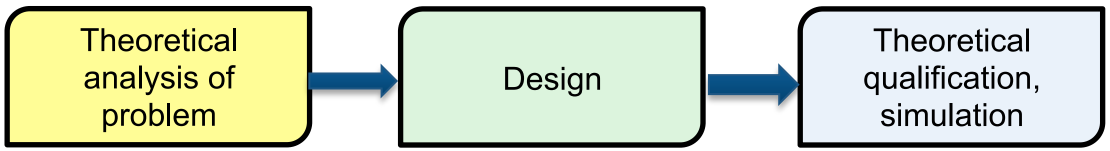
- Dynamic Thomson-based channel selection
  - Learn from previous attempts

- Extend to multi-hop
  - Sender selects N channels with this technique
  - Receiver selects one listening channel

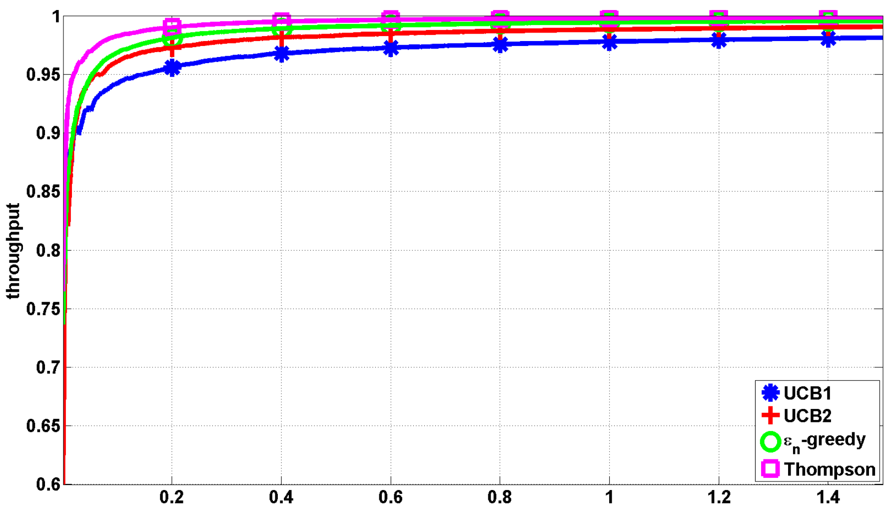


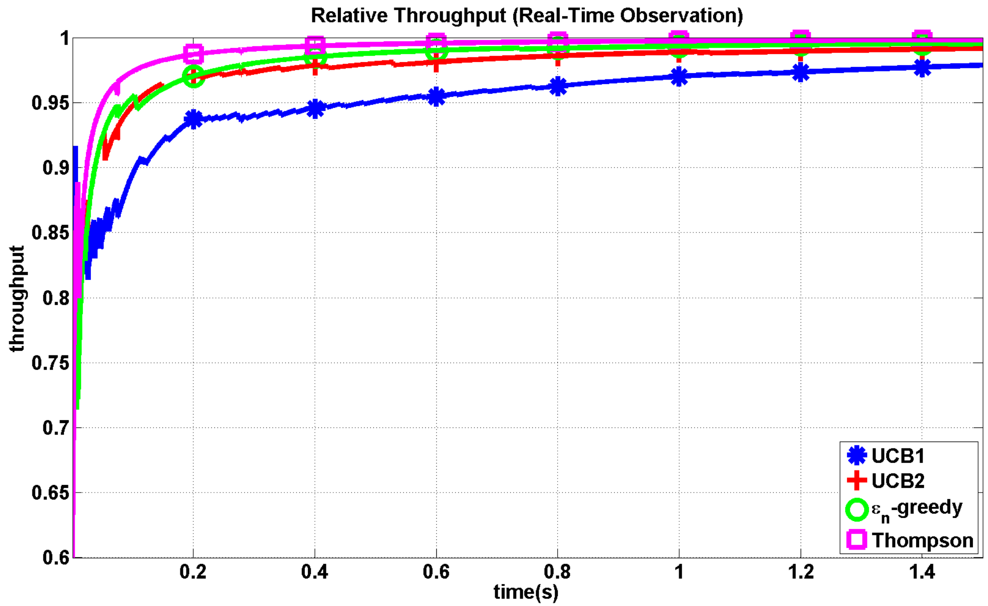
Our approach – Evaluation

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



Our approach – Testbed Evaluation





Theoretical analysis of problem → Design → Theoretical qualification, simulation → Validation via lab experimentation

Our approach – Testbed Evaluation

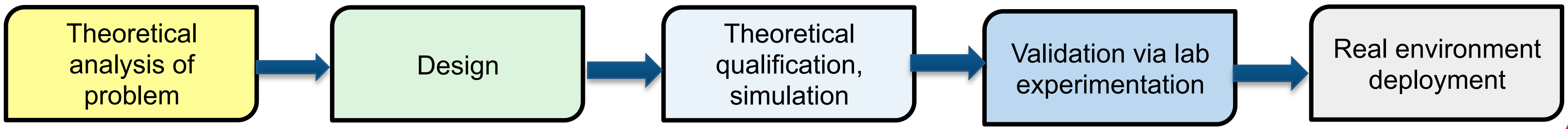
Theoretical analysis of problem → Design → Theoretical qualification, simulation → Validation via lab experimentation → Real environment deployment

Remaining work

- Still remains the integration

- The complete live deployments (not a piece of cake)

- And so interesting stuffs ;)



A concrete example

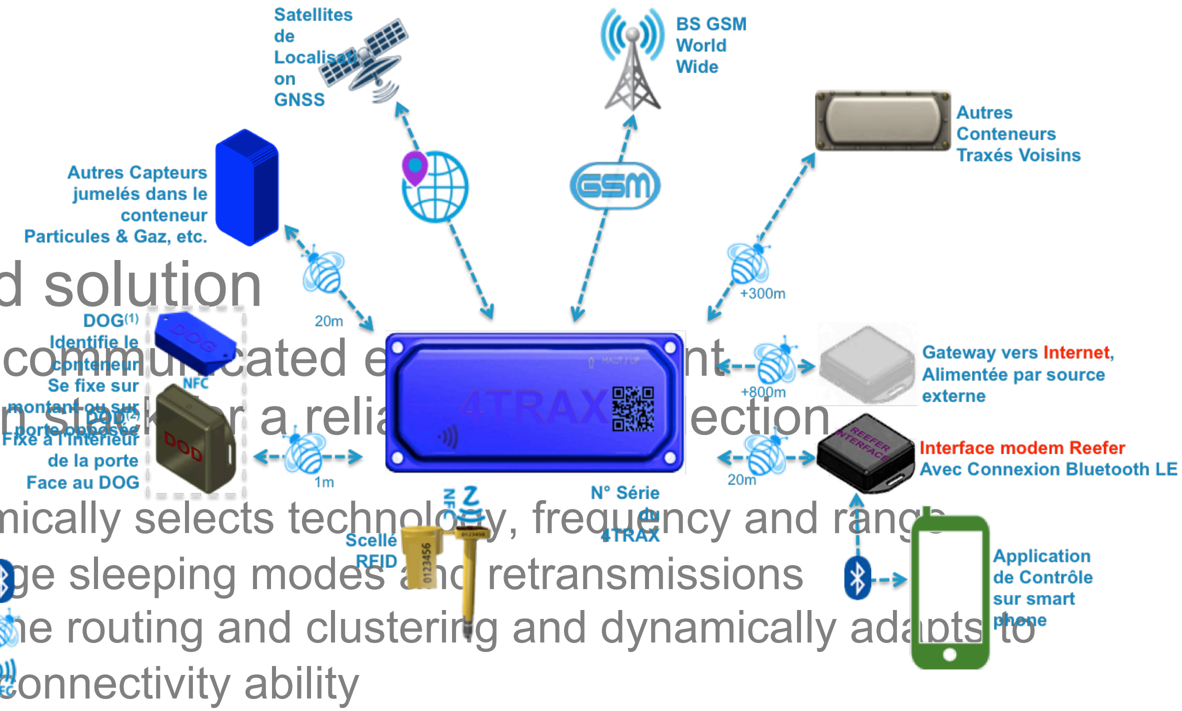
Container tracking : Traxens' use case

- Requirements
  - Trace containers in real time everywhere in the world
  - Detect door opening, change in temperature, humidity, etc
  - Long lifetime (minimum 3 years, optimally 7 years)
  - No packet loss
- Constraints
  - Changing topologies (ships, harbors, trucks, trains, etc)
  - Metal
  - Intermittent GSM / GPS connectivity
- No existing solution

Theoretical analysis of problem

Container tracking : Traxens' use case

- ❑ Hardware
- ❑ Software
  - ❑ A distributed solution
  - ❑ An integrated communicated equipment communication stack for a reliable connection
    - PHY : dynamically selects technology, frequency and range
    - MAC : manage sleeping modes and retransmissions
    - NET : combine routing and clustering and dynamically adapts to energy and connectivity ability



Theoretical analysis of problem → Design

Clustering in TraxNet

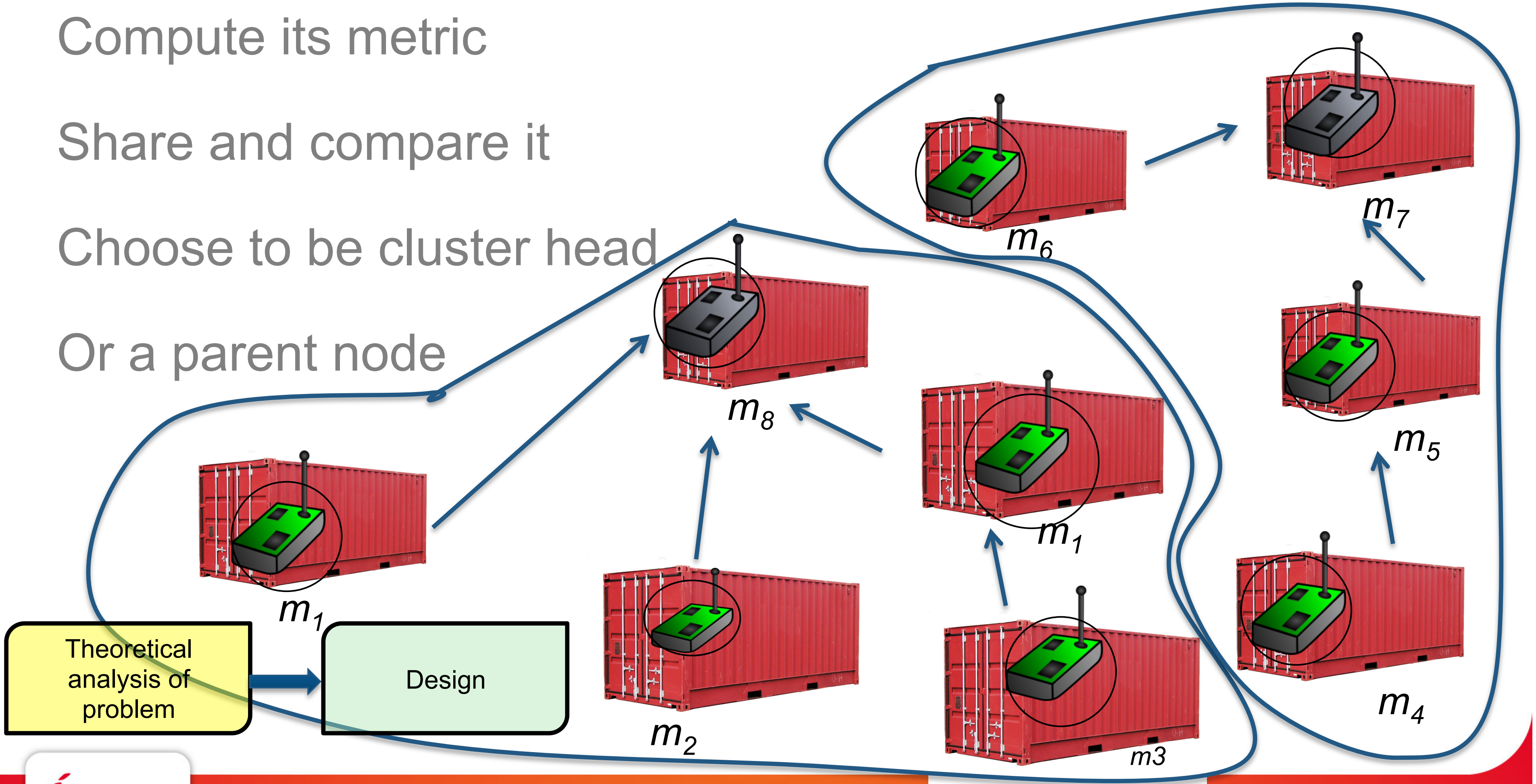
Locally check battery level and connectivity

Compute its metric

Share and compare it

Choose to be cluster head

Or a parent node



Container tracking : Traxens' use case

- Proven self-stabilizing
- Theoretically qualified (stochastic geometry)
  - Upper bound of the size of the cluster in number of hops
  - Upper bound of the number of nodes per cluster
  - → *Allowing energy consumption and lifetime estimations*

$$NC = \sum_{v} P(v = CH)$$

$$P(v = CH) = P(\nexists w \in N(v) st\, m_w > m_v)$$

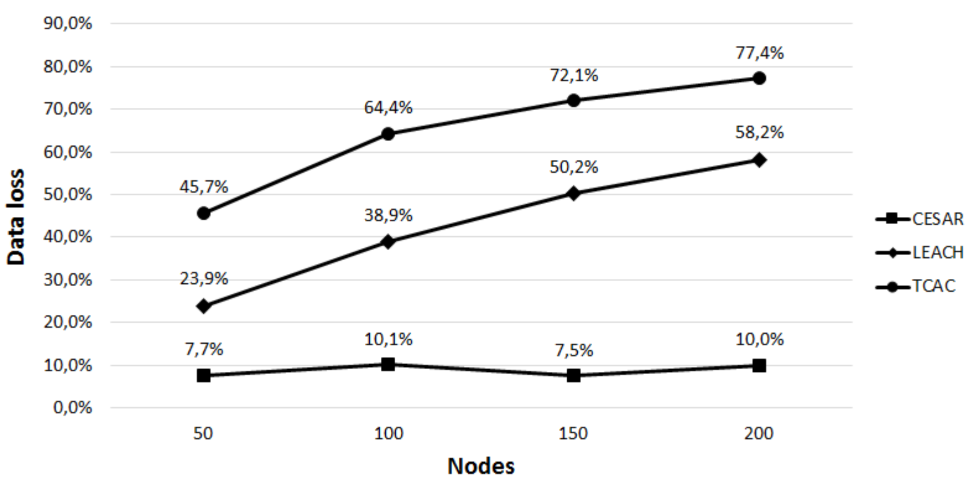
Poisson distribution then specific container topologies
Signal reception probability

Theoretical analysis of problem → Design → Theoretical qualification, simulation

Important results – interoperability and transfer (3)

- Stressed and calibrated on controled experimental environment (FIT IoT Lab)

- Calibrated on in-field experiments



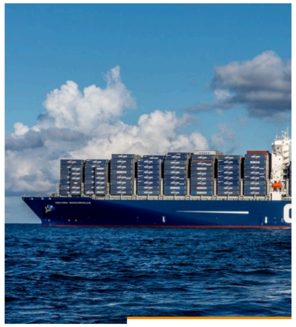
(a) TRAX-NET network test in the parking of Hôtel Technoptic in Marseille.

Theoretical analysis of problem → Design → Theoretical qualification, simulation → Validation via lab experimentation

Important results – interoperability and transfer (3)

- Real life experimentation
- 3 patents in

L'énorme «Bougainville», en escale à Dunkerque ce vendredi avec ses conteneurs



Le Bougainville, long
l'état de ses 18.000
connectés. Il sera ina

Commenter
Partager
Tweeter
Partager
Imprimer

Le traçabilité des conteneu
sera possible sur toutes
innovations du plus gros
François Hollande inaugure

Le nouveau porte-conteneurs Bougainville de CMA-CGM est un navire connecté !

oct 16, 2015 Geoffray GPS, Transports

En escale au Havre au début du mois, le nouveau porte-conteneurs de la compagnie française CMA-CGM est le plus grands de sa flotte, mais également l'un des navires marchands les plus connectés !

La compagnie maritime française CMA-CGM, troisième plus gros armateur du monde, est l'heureuse propriétaire d'un nouveau navire, baptisé Bougainville, un mastodonte affecté à la ligne Europe/Asie qui peut transporter 17 220 conteneurs.

Theoretical analysis of problem → … → simulation → experimentation → Real environment deployment

Conclusions

Internet of Things

Imagine a world where every object has the capacity to communicate with its environment. Everything can be both analogue and digitally approached - reformulates our relationship with objects –- things -- as well as the objects themselves. Any object … relates not only to you, but also … to other objects, relations or values in a database. In this world, you are no longer alone, anywhere.

Internet of Things council

THANK YOU

Inria

INVENTEURS DU MONDE NUMÉRIQUE