# IoT challenges

## State of the art

Aghiles DJOUDI

LIGM/ESIEE Paris & SIC/ECE Paris

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# Outline

# Context

## What is IoT ?

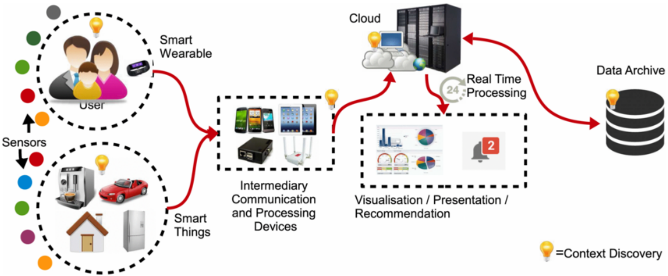


Figure 1: IoT platform.


Figure 2: IoT challenges.

# Problematic

## Where is the problem ?

1. How to Connect sensors to the best gateway?
   - ➟ Decision and optimisation problem.
   - ➟ Various network acces
   - ➟ Various configuration of each network acces
   - ➟ Lake of selection tools
2. How to connect sensors to this gateway with high Security level.
   - ➟ Technical problem.
   - ➟ Lake of selective tools
   - ➟ How to select the **best** access point
3. How to extract knowledge from sensors data [1].
   - ➟ a
   - ➟ Lake of selective tools
   - ➟ How to select the **best** access point

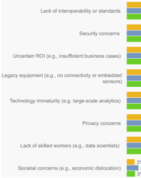


Figure 3: Key b
Industr

[a] industrialinternetofthings_

[1] Pascal Thubert, Maria Rita Palattella, and Thomas Engel. “ 6TiSCH Centralized Scheduling: When SDN Meet IoT ”. In: *2015 IEEE Conference on Standards for Communications and Networking (CSCN).* 2015 IEEE Conference on Standards for Communications and Networking (CSCN). 00035. Tokyo, Japan: Oct. 2015, pp. 42–47.

# Problematic

## Where is the problem [3] ?

Bandwidth (*BW*) Spreading Factor (*SF*) Coding Rate (*CR*) Transmission Energy (*Tx*) Receiver Sensitivity (*RS*) Signal Noise Rate (*SNR*) Data Rate (*DR*) ,Air Time (*AT*)

| Setting | Values | Rewards | Cost |
|---|---|---|---|
| *BW* | 7.8 ➠ 500$kHz$ | *DR* | *RS*, Range. |
| *SF* | $2^6$ ➠ $2^{12}$ | *RS*, Range | *DR*, *SNR*, longer packets, *Tx*. |
| *CR* | $4/5$ ➠ $4/8$ | Resilience | longer packets, *Tx*, *AT*. |
| *Tx* | $-4$ ➠ 20$dBm$ | *SNR* | *Tx* |

Table 1: [2]

# Motivations

## Why should we deal with such problems

1. ➟ a
   ➟ Lake of selective tools
   ➟ How to select the **best** access point
2. QoS Analysis
   ➟ a
   ➟ Lake of selective tools
   ➟ How to select the **best** access point
3. Threats
   ➟ a
   ➟ Lake of selective tools
   ➟ How to select the **best** access point

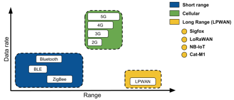


Figure 4: Communication diversity.

# Goal

## Is it specific, measurable, achievable, réalistic, for 3 years ?

- 1. Allow heterogeneous network to communicate
  2. QoS Analysis
  3. Threats
- How to select the **best** access point
  1. Allow heterogeneous network to communicate
  2. QoS Analysis
  3. Threats


Figure 5: wsn-IoT.

# Challenges

## Where is the difficulty ?

- Reasonable and acceptable delay before the decision appears.
- Cope with the different view points and goals of the operators and the users.
- React to the changing environment conditions.
- Allow any type of inputs and to be applicable to any type of ANs.
- Handle the increasing number of RATs and the large number of criteria.

# Contributions

## Contributions

- Use cases (Requirements)
  - Smart building: Videos, Voice, Text.
  - Smart trafic: Videos, Voice, Text
- Environnements
  - Rural/Urban
  - Static/Mobile
  - Tempirature
- Senarios
  - For each application protocol (MQTT, COAP, XMPP)
  - For each network protocol (Start, Mesh)
  - For each MAC protocol (LoraWan, Sigfox, ...)
- Algorithms
  - Input:
    - Service QoS metrics requiremnts
    - MAC configuration (SF, CR, BW, ...)
    - Network QoS metrics
  - Method:
    - MADM, Game, Neural
  - Outputs:
    - Ranked networks

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Simulation & Real environnement

# Outline

# Outline

1. Introduction

2. First contribution

3. Conclusion

1. Related work
2. Contagion process
3. Experimentation
4. Results exploitation
5. Discussion

# Outline

# Related work

## Comparison

| Paper | A1 | A2 | A3 | A4 |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Table 2: An example table.

# Related work

## Comparison

| Paper | A1 | A2 | A3 | A4 |
| --- | --- | --- | --- | --- |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Table 3: An example table.

# Outline

# Multi-Armed-Bandit Algorithm

## Methods

- Arms: K = 1, ... , K
- Decision: T = 1, ... , T
- Reward: $X_t^k$ with $\mu_t^k = \mathrm{E}\,[X_t^k]$
  - Best reward: $X_t^*$ with $\mu_t^* = \max \mu_t^k$, k∈K

# Genetic Algorithm

## Methods [4]

- Heterogeneous wireless network: ($RAT_1$ ,$RAT_2$ ,...,$RAT_n$)
- Criteria up to i ($c_1$ ,$c_2$ ,...,$c_i$ ) the operators, the applications, and the network conditions.
- 
- The different sets of scores ($d_1$ , $d_2$ ,...,$d_i$ ) are sent to the MCDM in the second component.
- GA component assigns a suitable weight ($w_1$ ,$w_2$ ,...,$w_i$ )

# Marcov chain

## Methods

$$V(s,\pi) = \mathbb{E}_s^{\pi}\left(\sum_{k=0}^{\text{inf}} \gamma^k \cdot r(s_k, a_k)\right), s \in \mathbb{S} \tag{1}$$

$$r(s_k, a_k) = G_k \cdot PRR(a_k) \tag{2}$$

$$\pi^* = \arg\max_{\pi} V(s,\pi) \tag{3}$$

$$PRR = (1 - BER)^L \tag{4}$$

$$BER = 10^{\alpha e^{\beta SNR}} \tag{5}$$

HGHG

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$$PRR = (1 - BER)^L \tag{4}$$

$$BER = 10^{\alpha e^{\beta SNR}} \tag{5}$$

# Genetic Algorithm

## Methods

- 
- S = SF12, BW125, 4/8, 17 dBm
- Input:
  - Problem: f(x) = max($x^2$), x ∈[0,32]
    - $x_1 : 01101_b$
    - $x_2 : 11000_b$
    - $x_3 : 01000_b$
    - $x_4 : 10011_b$
- Method: Genetic algorithm
  - Generate a set of random possible solution
  - Test each solution and see how good it is (ranking)
    1. Remove some bad solutions
    2. Duplicate some good solutions
    3. Make small changes to some of them (Crossover, Mutation)
- Output:
  - $x_1$: 01101 (169) (14.4)
  - $x_2$: 11000 (576) (49.2)
  - $x_3$: 01000 (64 ) (5.5)
  - $x_4$: 10011 (361) (30.9)

# Game theory

## Methods

- Players: $K = \{1,...,K\}$
- Strategies: $S = S_1 \times \ldots \times S_K$
  - $S_k$ is the strategy set of the $k^{th}$ player.
- Rewards: $u_k : S \longrightarrow R_+$ and is denoted by $r_k(s_k, s_{-k})$
  - $s_{-k} = (s_1, \ldots, s_{k-1}, s_{k+1}, \ldots, s_K) \in S_1 \times \ldots \times S_{k-1} \times S_{k+1} \times \ldots \times S_K$

# ... (step 2)

## Methods

# ... (step 3)

## Methods

➠

➠

# ... (step 4)

## Methods

➠

➠

# Results

## Comparison

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Table 4

# Outline

# Experimentation

## Experimentation

- a
- b

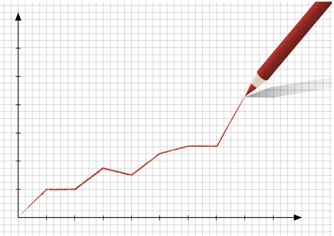

Figure 6: .

# Outline

# Results

## Comparison

- a
- b

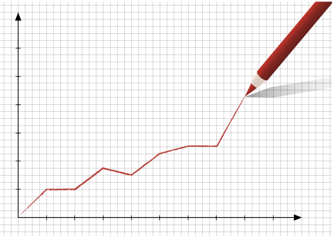

Figure 7: .

# Outline

# Discussion

- a
- b

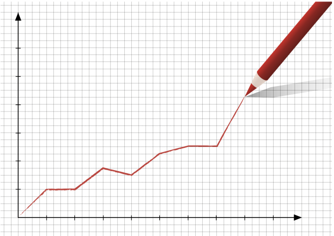

Figure 8: .

# Outline

# Conclusion

Our main goal was

- 
- 

Our main contribution was

- 
- 

Our main results was

- 
- 

Our future goal was

- 
- 

# Future Challenges

## Conclusion

Our future goal was

- 
- 

# Thank you !

# References


[1] Pascal Thubert, Maria Rita Palattella, and Thomas Engel. "6TiSCH Centralized Scheduling: When SDN Meet IoT". In: *2015 IEEE Conference on Standards for Communications and Networking (CSCN).* 2015 IEEE Conference on Standards for Communications and Networking (CSCN). 00035. Tokyo, Japan: Oct. 2015, pp. 42–47 (p. 4).

[2] Marco Cattani, Carlo Boano, and Kay Römer. "An Experimental Evaluation of the Reliability of Lora Long-Range Low-Power Wireless Communication". In: *Journal of Sensor and Actuator Networks* 6.2 (2017). 00042, p. 7 (p. 5).

[3] B. Di Martino et al. "Internet of Things Reference Architectures, Security and Interoperability: A Survey". In: *Internet of Things* 1-2 (Sept. 2018). 00006, pp. 99–112 (p. 5).

[4] Mohammed Alkhawlani and Aladdin Ayesh. "Access Network Selection Based on Fuzzy Logic and Genetic Algorithms". In: *Advances in Artificial Intelligence* 2008 (2008). 00000, pp. 1–12 (p. 18).