

IoT challenges

State of the art

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Outline

1. Introduction

2. First contribution

3. Conclusion

Context

What is IoT ?

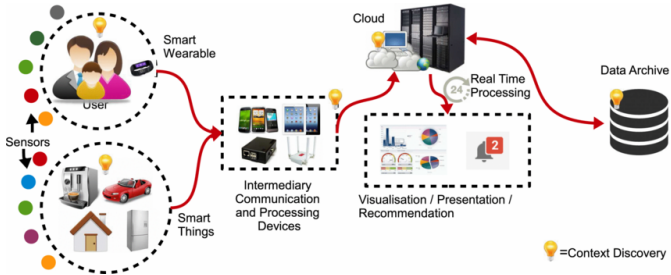


Figure 1: IoT platform.



Figure 2: IoT challenges.

Problematic

Where is the problem ?

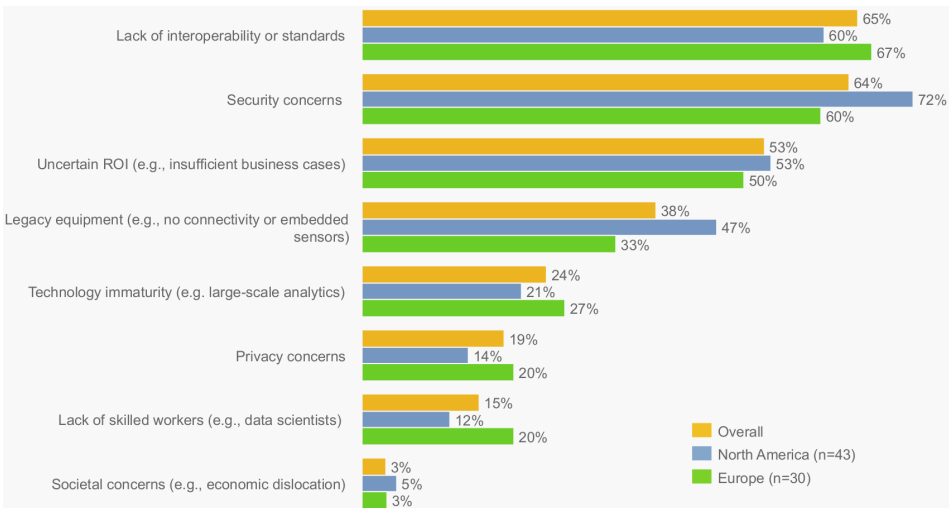


Figure 3: Key barriers in adopting the Industrial Internet [industrialinternetofthings_executive_].

Problematic

Where is the problem ?

1. Some network configuration are static and not adptive to the application

- Decision and optimisation problem..
- Various network acces
- Various configuration of each network acces
- Lake of selection tools

2. Users have to select the network and the application

- How to select the **best** network.
- How to select the network required by the application.

Problematic

Where is the problem [2] ?

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 |
|-----------|--------------------------|--------------------------|------------------------------------------------------|
| <i>BW</i> | 7.8 \Rightarrow 500kHz | <i>DR</i> | <i>RS</i> , <i>Range</i> . |
| <i>SF</i> | $2^6 \Rightarrow 2^{12}$ | <i>RS</i> , <i>Range</i> | <i>DR</i> , <i>SNR</i> , longer packets, <i>Tx</i> . |
| <i>CR</i> | 4/5 \Rightarrow 4/8 | Resilience | longer packets, <i>Tx</i> , <i>AT</i> . |
| <i>Tx</i> | -4 \Rightarrow 20dBm | <i>SNR</i> | <i>Tx</i> |

Table 1: [1]

Motivations

Who & why cares 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

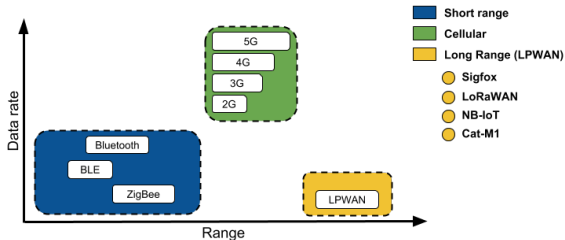


Figure 4: Communication diversity.

Goal

What is the goal ?

- ➡ 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.

Goal

What is the goal ?

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



Figure 5: wsn-IoT.

Map the network to service requirement ?

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 traffic: Videos, Voice, Text
- ➡ Environnements
 - ➔ Rural/Urban
 - ➔ Static/Mobile
 - ➔ Temperature
- ➡ Scenarios
 - ➔ For each application protocol (MQTT, COAP, XMPP)
 - ➔ For each network protocol (Star, Mesh)
 - ➔ For each MAC protocol (LoRaWan, Sigfox, ...)
- ➡ Algorithms
 - ➔ Input:
 - * Service QoS metrics requirements
 - * MAC configuration (SF, CR, BW, ...)
 - * Network QoS metrics
 - ➔ Method:
 - * MADM, Game, Neural
 - ➔ Outputs:
 - * Ranked networks

Contributions

Contributions

➡ Use cases (Requirements)

- ➡ Smart building: Videos, Voice, Text.
- ➡ Smart traffic: Videos, Voice, Text

➡ Environnements

- ➡ Rural/Urban
- ➡ Static/Mobile
- ➡ Temperature

➡ Scenarios

- ➡ For each application protocol (MQTT, COAP, XMPP)
- ➡ For each network protocol (Star, Mesh)
- ➡ For each MAC protocol (LoraWan, Sigfox, ...)

➡ Algorithms

➡ Input:

- * Service QoS metrics requirements
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➡ Method:

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➡ Outputs:

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Theoretical, Simulation & Real environment

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1. Related work

2. Contagion process

3. Experimentation

4. Results exploitation

5. Discussion

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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.

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Multi-Armed-Bandit Algorithm

Methods

- ➡ Arms: $K = 1, \dots, K$
- ➡ Decision: $T = 1, \dots, T$
- ➡ Reward: X_t^k with $\mu_t^k = E[X_t^k]$
 - ➡ Best reward: X_t^* with $\mu_t^* = \max_{k \in K} \mu_t^k$

Genetic Algorithm

Methods [alkhawlani_access_2008a]

- ➡ Heterogeneous wireless network: (RAT 1 ,RAT 2 ,...,RAT n)
- ➡ Criteria up to i (c_1, c_2, \dots, c_i) the operators, the applications, and the network conditions.
- ➡
- ➡ The different sets of scores (d_1, d_2, \dots, d_i) are sent to the MCDM in the second component.
- ➡ GA component assigns a suitable weight (w_1, w_2, \dots, w_i)

Marcov chain

Methods

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

$$r(s_k, a_k) = G_k \cdot PRR(a_k) \quad (2)$$

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

$$PRR = (1 - BER)^L \quad (4)$$

$$BER = 10^\alpha e^{\beta SNR} \quad (5)$$



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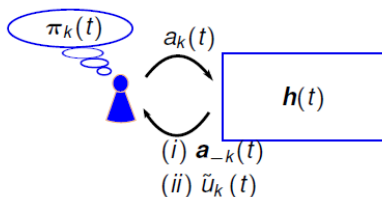
$$\pi^* = \arg \max_{\pi} V(s, \pi) \quad (3)$$

$$PRR = (1 - BER)^L \quad (4)$$

$$BER = 10^{\alpha} e^{\beta SNR} \quad (5)$$

Learning Iterative Steps:

- **Choose** action $a_k(t) \sim \pi_k(t)$.
- **Observe** game outcome, e.g.,
 $\mathbf{a}_{-k}(t)$
 $u_k(a_k(t), \mathbf{a}_{-k}(t))$.
- **Improve** $\pi_k(t+1)$.



Thus, we can expect that: $\forall k \in \mathcal{K}$,

$$\pi_k(t) \xrightarrow{t \rightarrow \infty} \pi_k^* \quad (1)$$

$$\bar{U}_k(\pi_k(t), \pi_{-k}(t)) \xrightarrow{t \rightarrow \infty} \bar{U}_k(\pi_k^*, \pi_{-k}^*) \quad (2)$$

where, $\pi^* = (\pi_1^*, \dots, \pi_K^*)$ is a NE strategy profile.

Figure 6: .

Genetic Algorithm

Methods



➡ S = SF12, BW125, 4/8, 17 dBm

➡ Input:

➡ Problem: $f(x) = \max(x^2)$, $x \in [0,32]$

* $x_1 : 01101_b$

* $x_2 : 11000_b$

* $x_3 : 01000_b$

* $x_4 : 10011_b$

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

... (step 2)

Methods



... (step 3)

Methods



... (step 4)

Methods



Results

Comparison

| | | | | |
|--|--|--|--|--|
| | | | | |
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Table 4

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Experimentation

Experimentation

➡ a

➡ b

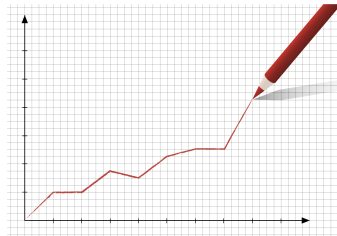


Figure 7: .

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Results

Comparison

➡ a

➡ b

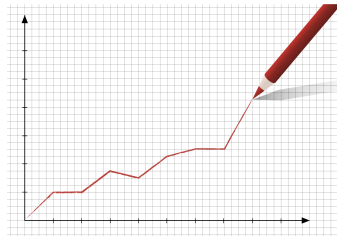


Figure 8: .

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Discussion

➡ a

➡ b

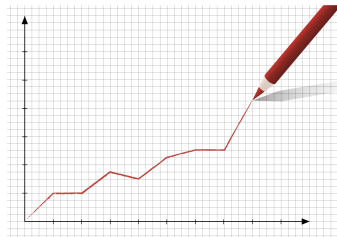


Figure 9: .

Outline

1. Introduction
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Conclusion

Our main goal was



Our main contribution was



Our main results was



Future Challenges

Conclusion

Our future goal was



Future Challenges

Conclusion

Our future goal was



Thank you !

References

- [1] 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. 6).
- [2] 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. 6).