IoT challenges

State of the art

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Outline

Context
What is IoT ?

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context.png
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Problematic

Where is the problem ?

stat_interoperability.png

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
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: [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

LPWAN.png

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

wsn-IoT.png

Figure 5: wsn-IoT.

Goal

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    2. QoS Analysis

    3. Threats

➠ How to select the **best** access point

    1. Allow heterogeneous network to communicate

    2. QoS Analysis

    3. Threats

wsn-IoT.png

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

- ➡ 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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Theoretical, Simulation & Real environnement

Outline

Outline

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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.

Outline

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 $\mu_t^* = \max \mu_t^k$, $k \in K$

Genetic Algorithm
Methods [**alkhawlani_access_2008a**]

- 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

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

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

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

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

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

HGHGJ

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Marcov chain

Methods

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: $K = \{1, ..., K\}$

➡ Strategies: $S = S_1 \times ... \times S_K$

→ S_k is the strategy set of the kth player.

➡ Rewards: $u_k : S \longrightarrow R_+$ and is denoted by $r_k(s_k, s_{-k})$

→ $s_{-k} = (s_1, ..., s_{k-1}, s_{k+1}, ..., s_K) \in S_1 \times ... \times S_{k-1} \times S_{k+1} \times ... \times S_K$

... (step 2)

Methods

➠

➠

... (step 3)
Methods

➡

➡

... (step 4)
Methods

Table 4

Outline

Experimentation

Experimentation

➡ a

➡ b
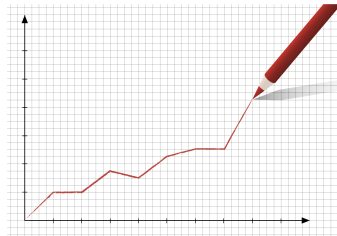
Figure 7: .

Outline

Results
Comparison

- a

- b
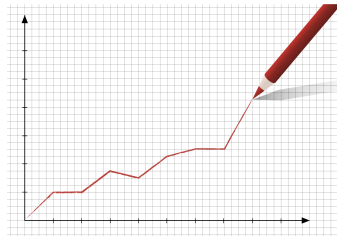
Figure 8: .

Outline

Discussion

- a
- b
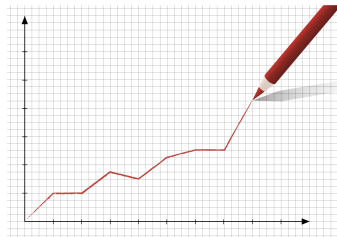
Figure 9: .

Outline

Conclusion

Our main goal was

➠

➠

Our main contribution was

➠

➠

Our main results was

➠

➠

Future Challenges

Conclusion

Our future goal was

➡

➡

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**).